

Artificial Intelligence in Higher Education at Worcester Polytechnic Institute



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An Interactive Qualifying Project Report
Submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the
Degree of Bachelor of Science

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Date: May 13, 2020

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This report represents work of WPI undergraduate students submitted to the faculty as evidence of a degree requirement. WPI routinely publishes these reports on its web site without editorial or peer review. For more information about the project program at WPI, see <http://www.wpi.edu/Academics/Projects>.

Abstract

Our study investigated how Artificial Intelligence might affect higher education at Worcester Polytechnic Institute in terms of, among other things: enrollment process, learning and instruction, personalized career planning, and student experience. Our first objective was to determine what experts think the impact of AI will be on how universities conduct their business. Our second objective was to address some of the possible ethical concerns with using AI in higher education. Finally, we made recommendations for WPI to implement AI using the feedback from experts.

Acknowledgements

Our team would like to thank the many individuals who volunteered their time and expertise for the success and outreach of this project. In particular, we would like to thank our advisor and sponsor Professor Joseph Doiron for providing us with a project full of opportunities and learning.

We would like to express our gratitude to all the Artificial Intelligence (AI) experts, ethicists and Higher Education Administration, representing organizations who participated in our surveys, including Worcester Polytechnic Institute, Massachusetts Institute of Technology, Northeastern University, Rochester Institute of Technology, University of Massachusetts Amherst, Arizona State University, and others. Each of these organizations provided a better understanding of Artificial Intelligence in Higher Education and shared any information they could to help us construct recommendations for management at Worcester Polytechnic Institute. We would like to thank ethics expert Jennifer deWinter, among other anonymous ethics experts, for their ethical considerations.

We would like to acknowledge our advisors, Professors Joseph Doiron and Kenneth Stafford, for their continual support, ideas, and motivation to fully investigate the potential of our project.

Finally, we would like to thank our fellow students on the D-Term Namibia IQP, whose feedback, support, and shared experiences inspired us to achieve greatness and support each other through a virtual project.

Executive Summary

The field of Artificial Intelligence is advancing rapidly with the advancement of new technology. The purpose of AI is to perform tasks that normally require human intelligence. Research in AI involves writing programs that attempt to achieve some kind of intelligent behavior. There are valuable applications of AI in many different aspects of science and engineering. These applications of AI are rooting in the foundations of the future of higher education. In order to remain competitive in the future higher education, universities will have to collaborate with AI implementation.

Project Goal and Objectives

The goal of this study was to explore the impact of Artificial Intelligence (AI) in higher education, specifically at Worcester Polytechnic Institute (WPI). We used Artificial Intelligence experts to guide a recommendation to the administration of Worcester Polytechnic Institute to increase their competitive standing by 2030 and 2050. The objectives to reach this goal were as follows:

- Gather expert opinions on how AI could be beneficial to higher education
- Make recommendations for WPI to improve using AI
- Address some of the possible ethical concerns with using AI in higher education

Our objective was to gather expert opinions on how AI could be beneficial to higher education in areas including but not limited to; enrollment, student life, personalized career planning, and learning and instruction. Using a Delphi Study-Style three round survey, we gathered predictions about artificial intelligence in higher education from experts from all over the world.

Methodology and Results

To achieve our goals, we established a methodology that consisted of three rounds. We followed the methodology of a three round Delphi Study in order to achieve this deliverable.

In Round 1, we aimed to gather a broad scope of information from AI experts. We asked these AI experts to respond to open response questions in order to reduce response bias. In Round 2, we were seeking out a narrowed scope of information from AI experts and now including higher education experts. In Round 2, the higher education experts were able to speak to the feasibility of implementing these changes at WPI. In Round 2 we began retrieving consensus and divergence in our data by having the experts agree and disagree with predictions from other experts. In Round 3, we aimed to prompt AI experts to make a careful and critical examination of responses from previous rounds. In addition to creating more consensus and divergence through agreement with other experts, experts were also asked to allocate resources to different areas of AI. The categories included learning and instruction, student experience, enrollment, athletics, facilities and other. AI experts ranked each category in corresponded to how important this area will be to the future of AI. From this data we were able to gather the areas of focus for the future of AI in higher education.

After the conclusion of our three round Delphi Study we sent out an additional feedback survey to WPI administration. For this survey we provided WPI faculty with a brief report of the findings from our Delphi Study. Using this report to guide their decisions, the WPI administration allocated resources for the years 2030 and 2050. The goal of this feedback round was to find what WPI administration found to be the most important areas to focus on with AI.

The resource allocation for 2030 can be found in Figure 1 below. Learning and Instruction was given an average of 35 out of 100 points. After Learning and Instruction comes Student Experience and Enrollment with averages of 22 and 20 points respectively.

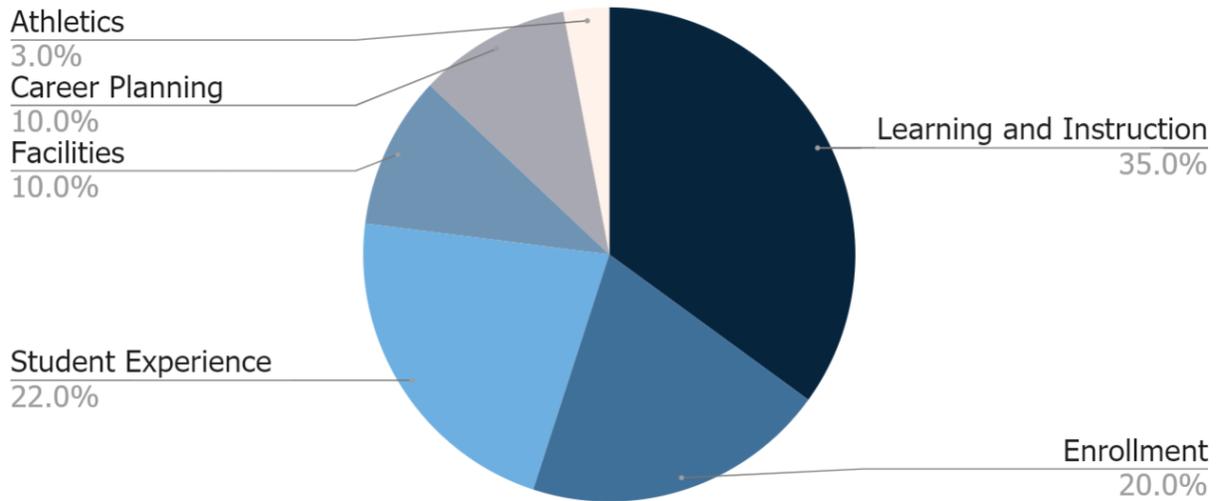


Figure 1: 2030 Resource Allocation Plan Visualization

The resource allocation for 2050 can be found in Figure 2 below. Learning and Instruction was given an average of 42 out of 100 points. After Learning and Instruction comes Enrollment and Student Experience with averages of 21 and 20 points respectively.

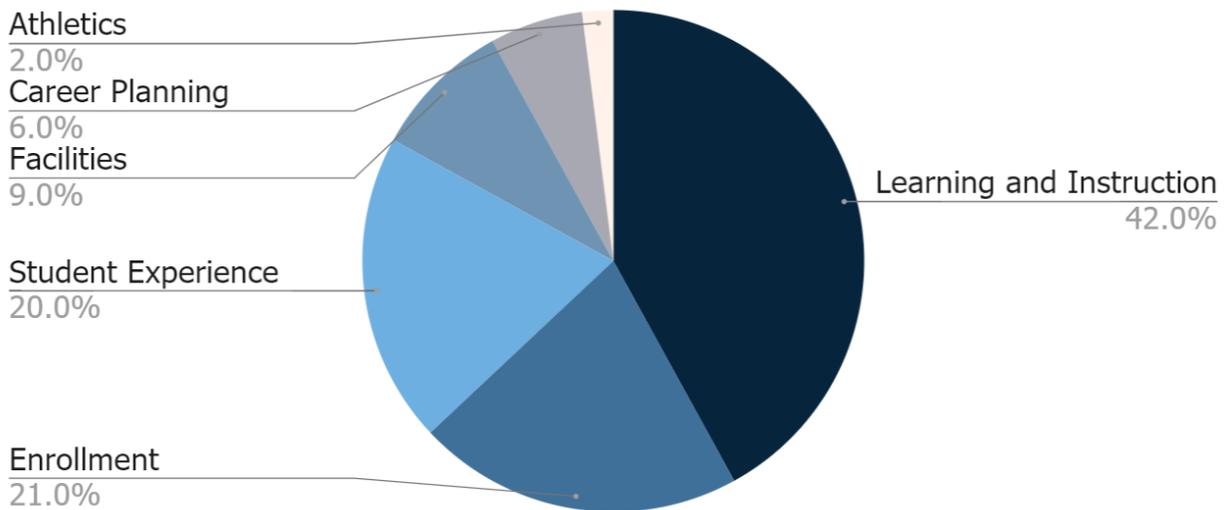


Figure 2: 2050 Resource Allocation Plan Visualization

Finally, we asked ethicists about their concerns following the conclusion of our survey. We sent emails to ethicists with an overall report summarizing the results of our study. The ethicists

then had the opportunity to raise any concerns regarding the ethics of introducing AI into higher education.

Deliverables

We provided deliverables following the conclusions of our project. Our expected deliverable for this study is to provide a comprehensive recommendation to WPI administrators on how to integrate AI into a WPI education. Following the conclusion of our project, we will provide the WPI administration with a publication regarding the best way to implement AI into higher education.

Potential Impact

This project provided Worcester Polytechnic Institute with a recommendation for how to implement Artificial Intelligence into higher education. The potential impact of this recommendation is to increase WPI's competitive standing against other universities.

Recommendations to WPI Administration

We used the combined results from our Delphi Study and our Resource Allocation round to develop a set of recommendations specific to WPI.

Recommendation 1: Learning and Instruction

We recommend that WPI invest the most of its AI resources into Learning and Instruction, specifically looking into Personalized Learning Material and Intelligent Agents.

Recommendation 2: Student Experience

We also recommend an investment in Student Experience, specifically focusing on how AI can provide Disability Assistance.

Recommendation 3: Facilities Management

Due to ethical concerns regarding privacy, we recommend WPI not invest resources into using AI for security purposes until these privacy concerns can be fully resolved.

Recommendation 4: Implementation as soon as possible

Finally, we noticed that the 2030 and 2050 results were quite similar across the board. This could indicate that AI is coming sooner rather than later. In order for WPI to hold the best competitive advantage, we recommend for WPI to invest in AI resources within the recommended categories as soon as possible.

Recommendations for Future Research

Recommendation 1: Larger Study

We recommend conducting a larger study that you could perform statistical analysis on. In future research outside the constraints of a virtual study, you can explore different types of data collection beyond online means. Consider a design sprint or a study that involves multiple experts discussing their predictions in person, this would lead to more collaboration between experts which could result in deeper insight.

Recommendation 2: Future Study

In addition, WPI should try another similar study in the near future. The year 2050 received less detailed responses in each survey and the results were similar to 2030. More detailed responses regarding 2050 could be achieved once a similar study is conducted in the future with whatever new technology is developed by then.

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<i>Ethical Considerations</i>	Logan	Lauren
<i>Recommendations to WPI</i>	Lauren	Logan
<i>Recommendations to other institutions</i>	Logan	Lauren
6.0 Conclusion	Rachel	All
Appendix		

TABLE OF CONTENTS

Abstract	iii
Acknowledgements	iv
Executive Summary	v
Project Goal and Objectives	v
Methodology and Results	vi
Deliverables	viii
Potential Impact	viii
Recommendations to WPI Administration	viii
Recommendations for Future Research	ix
Authorship	xi
List of Figures	xvi
List of Tables	xvi
1.0 INTRODUCTION	1
2.0 BACKGROUND	2
2.1 Current State of Higher Education	2
2.11 Cost and Availability	2
2.12 Value of a degree	3
2.13 Completion Rates	4
2.14 Current State of WPI	4
2.2 Artificial Intelligence	5
2.21 What is AI?	5
2.23 AI in Business	7
2.24 Teaching AI Strategy in Business Education	8
2.25 Opportunities for Businesses That Embrace AI	9
2.251 Blockchain automation	9
2.22 AI Ethics	10
2.26 Risks of AI	13
2.3 Delphi Study	14
3.0 METHODOLOGY	17
3.1 Methods Overview	17
3.2 Delphi Study	18
3.21 Round 1	18
3.22 Round 2	19
3.23 Round 3	20
	xiii

3.3 Feedback	21
3.31 Resource Allocation	21
3.32 Ethical Considerations	23
4.0 FINDINGS	25
4.1 Findings Overview	25
4.2 Round 1	26
4.21 Participants	27
4.22 Round 1: 2030	27
4.23 Round 1: 2050	29
4.3 Round 2	32
4.31 Participants	32
4.32 Round 2: 2030	33
4.33 Round 2: 2050	37
4.34 Round 2: 2030 vs. 2050	40
4.4 Round 3	42
4.41 Participants	42
4.42 Round 3: 2030	43
4.43 Round 3: 2050	48
4.44 Round 3: 2030 vs. 2050	51
4.5 Feedback	52
4.51 Participants	52
4.6 Resource Allocation	52
4.61 2030 Resource Allocation	53
4.62 2050 Resource Allocation	55
4.8 Framework of Categories	56
5.0 DISCUSSION	57
5.1 2030 Discussion	58
5.2 2050 Discussion	64
5.3 Resource allocations	64
5.4 Limitations of the Study	64
5.5 Ethical Considerations	65
6.0 CONCLUSION	67
References	71
Appendix A: Round 1 Survey	74
Appendix B: Round 2 Survey	77

Appendix C: Round 2 Detailed Report	87
Appendix D: Quotes from Experts (Round 2: 2030)	97
Appendix E: Quotes from Experts (Round 2: 2050)	101
Appendix F: Round 3 Survey	104
Appendix G: Round 3 Detailed Report	115
Appendix H: Feedback Survey	129
Appendix I: Ethics Interview Transcript	132
Appendix J: Ethics Expert Email	135
Appendix K: Informed Consent	136

List of Figures

Figure 1: 2030 Resource Allocation Plan Visualization	vii
Figure 2: 2050 Resource Allocation Plan Visualization	vii
Figure 3: Grid Participants used during Resource Allocation	23
Figure 4: Concept Map overview of concept revealed during the Delphi Study	26
Figure 5: Number of Times each University Category was selected (2030)	28
Figure 6: Number of Times each University Category was selected (2050)	30
Figure 7: Visual Summary of Round 2: 2030 Findings	35
Figure 8: Visual Summary of Round 2: 2050 Findings	39
Figure 9: Learning and Instruction: Online Courses Prediction 2030 vs. 2050	41
Figure 10: Facilities: Campus Maintenance Prediction 2030 vs. 2050	42
Figure 11a: Visual Summary of Round 3: 2030 Findings Key	45
Figure 11b: Visual Summary of Round 3: 2030 Findings	46
Figure 12: Visual Summary of Round 3: 2050 Findings	49
Figure 13: 2030 vs. 2050 Rankings of Importance	51
Figure 14: 2030 Resource Allocation Plan Visualization	54
Figure 15: 2050 Resource Allocation Plan Visualization	55
Figure 16: Word Cloud representation of Ethicist Feedback	65

List of Tables

Table 1: Categories of Round 3 Statements	20
Table 2: Breakdown of Participants for Round 1	27
Table 3: Participant Responses explaining why they selected University Categories (2030)	29
Table 4: Participant Responses explaining why they selected University Categories (2050)	31
Table 5: Number of Experts Participating in Round 2	32
Table 6: Categories and Subcategories of 2030 Section of Round 2 Survey	33
Table 7: Categories and Subcategories of 2050 Section of Round 2 Survey	38
Table 8: Number of Experts Participating in Round 3	43
Table 9: Categories and Subcategories of 2030 Section of Round 3 Survey	44
Table 10: Categories and Subcategories of 2050 Section of Round 3 Survey	48
Table 11: Resource Allocation Participants	52

1.0 INTRODUCTION

Our study investigates how Artificial Intelligence, or AI, might affect higher education in the near and distant future. In our preliminary research, we investigated some of the areas for improvement within higher education. These include, but are not limited to, the enrollment process, learning and instruction, personalized career planning, and the student experience. AI currently has many applications in the business world. There exists a great research opportunity to explore how AI capabilities might translate from business to higher education issues. Our project goal was to explore the impact of AI in higher education, specifically at Worcester Polytechnic Institute by 2030 and 2050.

Our objectives were:

- Determine what experts believe the impact of AI will be on how universities conduct their business.
- Address some of the possible ethical concerns with using AI in higher education.
- Make recommendations for WPI to improve using AI capabilities.

The desired outcome of our project is to increase WPI's competitive standing in higher education. We included an intersection of AI technical experts from around the world and WPI operations experts in order to make informed recommendations to WPI. Another impact of our study is the opportunity for AI and Higher Education researchers to develop a larger follow-up study based on the Framework of Categories we developed in our Findings.

2.0 BACKGROUND

2.1 Current State of Higher Education

2.11 Cost and Availability

One of the largest problems currently facing higher education institutions is the ever growing cost of attending them. In the early 2000s the average cost of attending a four year college, including room and board and other fees was around \$17,000 a year. By 2016 the cost of private universities had increased to almost \$50,000 a year (Lemke). The cost of tuition, housing, meal plans and other fees can be a major factor in students not attending certain colleges, or not going to college at all.

Due to the importance placed on education in today's society, state and government agencies have attempted to provide funding to allow students to continue their studies that may have otherwise not been able to. Between 1986 and 2007, the amount of financial aid given out by states increased by 40% and the amount of federal aid increased by 200%, but during this same time frame the cost of tuition also increased by over 90%. This statistic suggests that as students become able to pay more for higher education because of outside funding, the cost of higher education rises to meet it. This may be one of the reasons that despite the increased amount of financial aid, enrollment has only increased by 40% from 1986 to 2007.

While most colleges are either public or non profit and do not compete with other colleges for financial gain, they do compete for prestige. One of the easiest ways for a college to appear more prestigious is to spend money. Not only can a college gather more resources and newer equipment, but spending per student is itself a metric used to determine the best colleges by U.S.

News & World Report (Gillen). The average amount of spending per student has doubled in the same time frame as tuition has. Andrew Gillen argues that this is the reason that federal and state financial aid programs have not been successful in accomplishing what they were designed to do: “what the remainder of this analysis will argue is that viewing costs (spending) as fixed, and designing financial aid programs to address those costs is inappropriate, because we should expect one of the consequences of the financial aid programs to be changes in the level of costs (Gillen)”.

2.12 Value of a degree

An additional problem facing higher education institutions is the attack on the value of a degree. This problem has increased with the increasing cost of a degree. As the cost of tuition increases, students will be forced to weigh the cost of the degree against its worth when deciding whether or not to attend a college.

A major argument against the value of a college degree is that students are entering the workforce without the necessary skills to succeed despite their education. In a study conducted jointly by The Conference Board, Corporate Voices for Working Families, the Partnership for 21st Century Skills, and the Society for Human Resource Management, it was found that almost 10% of employers surveyed claimed that their employees who had a four year degree were not prepared for entry level jobs. Additionally less than 25% of employers said that their employees who had four year degrees were “excellently” prepared for entry level jobs. Almost 25% of employees were considered “deficient” in the category of leadership and almost 20% were considered “deficient” in professionalism and work ethic.

Former United States Secretary of Education Margaret Spellings stated that there were “...disturbing signs that many students who do earn degrees have not actually mastered the reading,

writing, and thinking skills we expect of college graduates. Over the past decade, literacy among college graduates has actually declined. Unacceptable numbers of college graduates enter the workforce without the skills employers say they need in an economy where, as the truism holds correctly, knowledge matters more than ever” (Castillo).

If AI could help prepare college students for the workforce by ensuring that they have the skills necessary to succeed, then it would help higher education institutions prove the value of their education.

2.13 Completion Rates

In recent years completion rates for higher education institutions have been well below desirable levels. From 2016 to 2017, open admission schools had a retention rate of only 59%. For students at 2-year degree colleges the retention rate was only 62%. Additionally, only 60% of students at 4-year colleges graduated within 6 years of beginning their enrollment while only 32% of students at 2 year colleges graduated within 3 years of beginning their enrollment. If graduation is to serve as an indicator of the successful education of students, then colleges are failing to properly educate a large percentage of their students (The Condition of Education). If AI could aid higher education institutions in retaining their students, then it could bring value to colleges by allowing them to bring in more tuition as well as adding to their prestige by increasing their retention rate.

2.14 Current State of WPI

The founders of Worcester Polytechnic Institute, or WPI, created a technical school in 1865 upon the idea of educating students in the surrounding area. WPI places a heavy focus on

student-centered learning, leadership, lifelong learning, and personal development. Today, WPI delivers education using project-based learning in primarily the fields of science, technology, engineering and mathematics. At WPI, courses are taught on an accelerated schedule in which students learn during 7 week long terms rather than typical 15 week semesters. Students complete three major projects in order to graduate: The Interdisciplinary Qualifying Project (IQP), The Humanities Inquiry Seminar, and the Major Qualifying Project (MQP). Most students complete both the IQP and MQP as part of a team. Currently, WPI supports both student and staff researchers. In 2019, WPI received over \$36 million for research funding. WPI has over 200 clubs on campus and 18% of students at WPI participate on one of the school's 20 NCAA varsity sports teams (WPI).

2.2 Artificial Intelligence

2.21 What is AI?

Artificial Intelligence is a branch of computer science- the study of the relation between computation and cognition. The purpose of AI is to perform tasks that normally require human intelligence. AI programs may mimic or simulate cognitive behaviors or traits associated with human intelligence such as reasoning, problem solving, and learning. Research in AI involves writing programs that attempt to achieve some kind of intelligent behavior. There are valuable applications of AI in many different aspects of science and engineering. Some applications include natural language processing to develop computer systems capable of generating and “understanding” even fragments of a natural language. Other applications are intelligent retrieval

from databases, expert consulting systems, theorem proving, robotics, automatic programming, and combinatorial and scheduling problems.

Machine intelligence is commonly used as a synonym for AI, but can also refer to forms of intelligence which are beyond or different from human intelligence, such as finding complex patterns in very large amounts of data. Machine Learning is essentially the process by which machines acquire knowledge. It generally focuses on analyzing data for patterns and relationships. Deep Learning goes much further and attempts to analyze the nature of the phenomena that the data represents, including discovery of rules of behavior, interactions, and strategy (Krupansky, 2017).

The beginning of modern AI can be traced to philosophers' attempts to describe human thinking as a symbolic system (Lewis, 2014). The field of AI was formally founded in 1956 when the term "artificial intelligence" was coined at a conference at Dartmouth College. MIT scientist Marvin Minsky, a conference attendee, can be quoted as saying "Within a generation, the problem of creating "artificial intelligence" will substantially be solved." (Basic Books, 1994). However, a completed artificially intelligent being would not be achieved as simply as Minsky theorized. After several reports criticizing progress in AI, government funding and interest in the field dropped off – a period from 1974–80, and again from 1987 to 1993, that became known as the "AI winter." (Lewis, 2014). But research began to pick up again after that, and in 1997, IBM's Deep Blue became the first computer to beat a chess champion when it defeated Russian grandmaster Garry Kasparov. And in 2011, the computer giant's question-answering system Watson won the quiz show "Jeopardy!" by beating reigning champions Brad Rutter and Ken Jennings. Even human emotion was targeted as evidenced by Kismet, a robot developed by Cynthia Breazeal that could recognize and display emotions. In 2014, the talking computer "chatbot" Eugene Goostman

captured headlines for tricking judges into thinking he was a human during a competition developed by British mathematician and computer scientist Alan Turing in 1950 as a way to assess whether a machine is intelligent. But the accomplishment has been controversial, with artificial intelligence experts saying that only a third of the judges were fooled, and pointing out that the bot was able to dodge some questions by claiming it was an adolescent who spoke English as a second language. In fact, some scientists now plan to develop an updated version of the test. But the field of AI has become much broader than just the pursuit of true, humanlike intelligence (Lewis, 2014).

There has been a surge in artificial intelligence technologies co-opted by or designed for people with disabilities. Researchers are constantly looking for ways for AI to improve the medical field, including machine learning to support neurosurgery. In addition, Artificial intelligence in Education (AIEd) is currently an emerging field in educational technology.

In today's society we have the capacity to collect huge sums of information too cumbersome for a person to process. With this application of artificial intelligence several industries such as technology, banking, marketing, and entertainment could benefit greatly. In the immediate future, AI language is a growing field. In the long term, the goal of some AI experts is general intelligence, a machine that surpasses human cognitive abilities in all tasks. Some experts believe that the capability of creating this 'sentient robot' is probable, however the ethical questions may present a barrier for its creation.

2.23 AI in Business

As artificial intelligence gains more popularity in businesses, executives must learn the best way to integrate AI into their existing business models. According to *Strategy for and With AI*, "A company's strategy is defined by its key performance indicators. Artificial intelligence can

help determine which outcomes to measure, how to measure them, and how to prioritize them” (Kiron & Schrage, 2019). Kiron & Schrage’s (2019) research strongly suggests that in a machine learning era, leadership teams must identify and justify their key performance indicators to remain competitive. Machine learning pioneers, such as Amazon, Google, Alibaba, and Netflix, have learned that focusing on strategies deployed with their core capabilities invariably leads to greater returns.

2.24 Teaching AI Strategy in Business Education

Bhalla (2019) presents a new framework, the 3S Process, as a method for teaching leaders how to strategically adopt AI into their organizations. Future leaders can leverage this 3S Process to encourage the emergence of creative thinking around integrating AI in business. This curriculum follows a Story, Strategy, Solution framework that can be adapted to teach both business students and current business leaders. In Stage 1: Story, students use the Harvard Case Method to provide the context of the problem to be solved. Current business leaders replace case studies with relevant projects within their company. For Stage 2: Strategy, students and business leaders alike use Design Thinking to produce candidate solutions. Bhalla (2019) recommends the original Design Thinking phases: Empathy, Define, Ideate, Prototype, and Test. The substage of Empathy in Design Thinking plays a crucial role to reduce bias in designing AI. Finally, in Stage 3: Solution, students advocate for their conceptual AI solution in the context of the case study. In the classroom or in the business context, followers of the new 3S Process develop an AI system, which is integrated into another product or service. The performance, or even the behaviour itself, of the system may change with the collection and variation of data over time. AI is a type of complex

system; therefore, students and business leaders alike should consider feedback loops and the potential for unintended biases to enter a deployed solution.

2.25 Opportunities for Businesses That Embrace AI

In *Applied Artificial Intelligence: Where AI Can Be Used In Business*, Corea (2019) explains some of the current and predicted opportunities for businesses that embrace AI. Speech recognition capabilities, known as Conversational User Interfaces (CUI), dominate the current wave of AI development. Corea (2019) describes three key avenues businesses can dominate in CUI: Employee Bots, Bots Contractors, and General User Interfaces. Employee Bots work in a specific industry or area of application as a stand-alone framework that does not necessitate extra training other than “plug and play”. Bots Contractors are similar to employee bots, except they are cheaper and less specialized than employee bots. General User Interfaces are native applications that represent the purest aspiration to a general conversational interface. The Amazon Alexa, Google Home, and Microsoft Cortana all represent classic General User Interfaces.

2.251 Blockchain automation

Corea (2019) predicts an innovative intersection between AI and blockchain automation in business. A blockchain is a secure, distributed, immutable database shared by all parties in a distributed network where transaction data can be recorded and easily audited. This intersection between AI and blockchain can lead industry leaders in blockchain to the following (Corea, 2019):

- Scalability: AI can introduce new decentralized learning systems such as federated learning, for example, to make the system more efficient.

- Security: Even if the blockchain is almost impossible to hack, its further layers and applications are not so secure (e.g., the DAO, Mt Gox, Bitfinex, etc.). The progress made by machine learning in the last two years makes AI a fantastic solution for the blockchain to guarantee a secure applications deployment.
- Efficiency: Deloitte (2016) estimated the total running costs associated with validating and sharing transactions on the blockchain to be as much as \$600 million a year. An intelligent system might be able to give miners the possibility to shut down low-likelihood tasks for that specific transaction and cut down the total costs.

2.22 AI Ethics

Ethical concerns are a main topic when discussing the possibility of using AI in new ways. Many concerns relate to ensuring that AI machines do not harm humans and to the moral status of the machines themselves. Robots are considered by most experts to be moral producers, even if they do not have the kind of autonomy that humans have, they at least have the capacity to make decisions which may be of considerable importance (Torrance). The main debates today include privacy and surveillance, manipulation of behavior, opacity of AI systems, bias in decision systems, human-robot interaction, automation and employment, and singularity. Singularity is the idea that if artificial intelligence reaches the point where they have a human level of intelligence, then these systems would themselves have the ability to develop AI systems that surpass the human level of intelligence (Corea, 2019).

Research has shown that AI picks up on racial and gender stereotypes when learning from what humans write. Without any supervision, a machine learning algorithm learns to associate female names more with family words than career words, and white names as being more pleasant

than names from other cultures (Bryson). In a study entitled *Semantics derived automatically from language corpora contain human-like biases*, researchers showed that machines learn what people know implicitly. The researchers replicated an array of known biases, using a widely used, purely statistical machine-learning model trained on standard text from the internet. The results indicated that the text contained recoverable and accurate imprints of our historic biases, whether morally neutral as toward insects or flowers, problematic as toward race or gender, or even simply veridical, reflecting the status quo distribution of gender with respect to careers or first names (Caliskan).

Privacy is a large ethical concern addressing AI such as facial recognition. Biometric data collection pushed by businesses such as facial recognition technology, selfies to check in to events, thumbprint to pay, and DNA for ancestral tours, all make it easier to collect information about you. AI can perform facial analysis, skin texture analysis, gait recognition, speech recognition and emotional recognition, all without permission or cooperation from the individual.

AI is also reshaping how we interact with each other. An experiment by Yale professor Nicholas Christakis showed that group dynamics in humans can be altered by introducing human-like bots. A group that cooperated to maximise collective returns altogether ceases to cooperate when selfish free-riding bots join the group. The reduced trust in the environment alters how we build connections and cooperate. Nicholas Christakis says, “As AI permeates our lives, we must confront the possibility that it will stunt our emotions and inhibit deep human connections, leaving our relationships with one another less reciprocal, or shallower, or more narcissistic (Christakis, 2019).”

Another problem that is raised when speaking about ethics in AI is data biases. Most of the data that humans produce inherits the same biases that we have as humans. Even in the case of a

perfect data set, we have no guarantee AI won't learn the same bias autonomously as we did. In other words, removing biases by hand or by construction is not a guarantee that those biases do not come out again spontaneously.

Another ethical dilemma involves liability. A medical doctor may use an algorithm to help them diagnose a specific disease. 99.99% of the time the computer gets it right. It analyzes billions of records and it sees patterns that a human eye can't perceive (Simmonds, 2016). But what if in the remaining 0.01% of the case the doctor's instinct tells them something opposite to the machine result and the doctor ends up to be right? What if the doctor decided to follow the advice the machine gave instead of their own and the patient dies? Who is liable in this case? In fact, algorithm aversion is becoming a real problem for algorithms-assisted tasks and it looks that people want to have an (even if incredibly small) degree of control over algorithms (Dietvorst et al., 2016). But above all: are we allowed to deviate from the advice we get from accurate algorithms? And if so, in what circumstances and to what extent?

AI democratization vs centralized AI is a policy concern that is important in AI ethics. AI democratization increases both the benefits and the rate of development but comes with all the risks associated with system collapse as well as malicious usages. If AI is centralized, who will control it and how should it be regulated? Regarding the AI decentralization, regulations would have to be strict enough to deal with cases such as AI-to-AI conflicts. For example, what would happen if two AIs made by two different people conflict and give different outcomes? Regulations might also deal with the ethical use of a certain implementation of AI. However, the regulations must not be so strict as to prevent research and development or full access to everyone (Dietvorst et al., 2016).

In a few decades, we went from the slogans “AI is impossible” (Dreyfus 1972) and “AI is just automation” (Lighthill 1973) to “AI will solve all problems” (Kurzweil 1999) and “AI may kill us all” (Bostrom 2014). This created media attention and public relations efforts, but it also raises the problem of how much of this “philosophy and ethics of AI” is really about AI rather than about an imagined technology. AI has raised questions about what we should do with these systems, what the systems themselves should do, and what risks they have in the long term.

2.26 Risks of AI

As with a multitude of technologies, there are risks that come with implementing AI in an everyday lifestyle. AI can be taught and has the ability to improve continuously when presented with new data (Goodman et al., 2020). Although most intentions are good, AI, as a powerful instrument, is capable of many things and thus can be implemented in both good and bad ways. Because AI only knows what it has been taught, it is not perfect and is prone to making mistakes. This is due to the belief that a lot of the data given to AIs is not perfect, and because the data AI learns from is not perfect, the output expected from AI cannot be perfect either. Some even believe that “since we are building artificial intelligence in our own image, it is likely to be both as brilliant and as flawed as we are” (Băjenescu, 2018).

With the increase in implementations of AI across the globe, more risks conjointly arise. The more commonly AI is applied to everyday life, the greater the risk factor on a global scale in multiple categories including, but not limited to, the entertainment and job industries (Băjenescu, 2018). In *The Risks of Artificial Intelligence* (2018), Titu-Marius I. Băjenescu makes the argument that “while the entertainment industry does offer significant opportunities for better education through personalized AI teaching and the gamification of learning material, it also increases the

risk that a growing proportion of young people will have trouble completing their education due to a pathological addiction to video games and/or the internet.” The increase in the application of artificial intelligence in the stage of one’s life when academia plays a key role, prompts the decrease of the desire and the focus that is necessary to learn. Also, as the application of AI increases in individuals’ everyday lifestyle, the need and desire for AI will grow consequently. This growth could potentially lead to the replacement of workers with AI, and lead to an increase in the unemployment rates. On the contrary, some believe that AI could actually create more job opportunities due to the fact that AI will need maintenance and data input from humans regardless (Băjenescu, 2018).

Another risk with the implementation of AI is the possible increased risk of terrorism and crime. AI could be used in such a way that would primarily work to disrupt a large group of people or an entire society with the intentions of performing harmful acts. Digital and cyber warfare could also potentially increase as the use of AI becomes more familiar. It will become more common to use AI in everyday life, and therefore, the risks of being subjected to digital warfare increase. AI could also be misused in the sense that it can be taught how to fire a gun or handle lethal weapons (Băjenescu, 2018). Some experts believe that AI should be supervised to ensure the risks are minimized, however, the risks should be known in case of potential ethical misuses, whether intentional or not.

2.3 Delphi Study

A Delphi Study is a type of study that presents a series of surveys or inquiries to a panel of experts of the topic of discussion in hopes of coming to a consensus on the best way of approaching this topic (Clibbens et al., 2012). This type of study was first developed in the 1950s by the RAND

corporation as a way to determine the future impact technology would have on warfare (RAND) and it has been successfully implemented in different research methods ever since.

The common Delphi Study consists of selecting an expert panel for questioning during the study, creating a series of questionnaires to be completed by this expert panel, and in most cases, three to four stages of the study to ensure a well-informed consensus has been reached (Clibbens et al., 2012). To appropriately select a panel of experts, the definition of an expert of the topic of discussion needs to be set. The appropriate experts need to be identified prior to the start of the study to ensure proper responses will be received during the study. The chosen experts should have reputable experience in their relative fields of expertise in order to be considered for this type of study (Clibbens et al., 2012). They should be trusted and respond in a timely manner to ensure the success of the study.

Once these experts have been identified, appropriate questions need to be developed for *Round 1* of the study in order to get appropriate responses from the panel of experts previously mentioned. Questions should be relative to the areas of the experts, should accurately demonstrate how much each panelist knows of the topic (Clibbens et al., 2012), and should allow panelists to depict their specific opinions on the topic of discussion. By formulating the questions in this manner, the most valuable responses will be obtained in each round of questionnaires. Once the responses from the first round of questioning have been obtained, these responses are arranged in a quantitative way and distributed back out to the participants for feedback in *Round 2* of the study. During the second round, participants are given the overall quantitative results of the first round and they are asked to share their opinions given the results of all experts from the first round of questioning. This round of the Delphi Study uses “numerical measures and descriptive statistics to establish strength of opinion on the items generated by the experts in the first round” (Clibbens et

al., 2012). Once the results from the first round have been distributed to the same experts during the second round and their feedback on the data collected is given (and new opinions have been given) the researchers will then move on to the next round. *Round 3* consists of the researchers taking the expert feedback and opinions obtained in the second round and determining if there is disagreement between the experts on the topic being explored in the Delphi Study. If there is, then this disagreement will be further explored and addressed in this round (Linstone and Turoff, 1975). By further discussing the origin of the disagreement, the disagreement can then be evaluated and potentially resolved through means of discussion. Once a consensus has been made in this round, the researchers proceed to *Round 4*. In the fourth (potentially third round if there is no existential disagreement after the second round) and final round, a final evaluation is made given the information received in the previous rounds (Linstone and Turoff, 1975). This final evaluation is sent to the panel of experts and their feedback is given to the researchers for consideration in developing a final result of the Delphi Study.

There are several benefits to this type of study. This type of study directly implements the opinions of experts of the topic in question. These experts will be able to share their own opinions on the topic given their own experiences in the field. This way, researchers are able to get a multitude of perspectives on the topic in question and understand the topic in a deeper way.

3.0 METHODOLOGY

3.1 Methods Overview

The goal of this study was to explore the impact of Artificial Intelligence (AI) in higher education, specifically at Worcester Polytechnic Institute (WPI). Our objective was to gather expert opinions on how AI could be beneficial to higher education in areas including but not limited to; enrollment, student life, personalized career planning, and learning and instruction. We asked experts to look at the years 2030 and 2050. The years 2030 representing a near future with current technology and the year 2050 representing a future with creative and new tech. Our expected deliverable for this study is to provide a comprehensive recommendation to WPI administrators on how to integrate AI into a WPI education.

We will follow the methodology of a three round Delphi-style Study in order to achieve this deliverable. We budgeted approximately one week for each round, with an additional buffer week built in for the case that we have a low response rate for any given round. In Round 1, we aimed to gather a broad scope of information from AI experts. We asked these AI experts to respond to open response questions in order to reduce response bias. In Round 2, we designed the questions to gain as many original ideas as possible from AI experts. In Round 3, we aimed to prompt AI experts to make a careful and critical examination of responses from previous rounds. We built feedback into the questions to produce consensus and divergence in this final round.

After the Delphi Study, we asked higher education experts to complete a resource allocation plan regarding the implementation of AI into higher education in order to determine the feasibility of implementing these changes at WPI.

3.2 Delphi Study

3.2.1 Round 1

In the first stage of the methodology, we gathered information from AI experts in industry and academia. Our goal for the first round was to gather expert opinion on the different ways that AI could change higher education, in both the short and long term. We designed a survey as the platform for AI experts to give their opinions. In the first wave of this stage, we distributed a survey to over 200 AI experts at various universities and businesses across the country. We formulated the survey questions in this round to allow the experts to give us a broad range of responses.

On the first page, the Round 1 survey asked AI experts to give their best estimate of how AI will change universities by 2030. This was designed to gather broad scope opinions on the near future of AI. The survey then directed AI experts to identify which university sectors could be improved with AI. This was designed as a checkbox question with the option for the AI expert to provide as many “other” sections as they see fit. The next question asked the experts to fully explain their choices for which university sectors will change with AI by 2030.

On the second page of the survey, we repeated the previous four questions for the scenario of 2050. Our goal for the second set of questions was to gauge the long term projections that AI experts may have in mind. For the best survey user experience, we decided to separate the 2030 and the 2050 questions onto different pages in hopes to reduce confusion. Appendix A, illustrates how the survey will appear to the study participants, including the welcome message. The results of the first round were used to create a framework for the second round of the study.

3.22 Round 2

In the second round, we anonymously shared thought-provoking responses from round 1 with another panel of AI experts, some of whom had participated in round 1. In round 2 participants had the opportunity to agree, disagree, and give additional comments in response to the first round responses. By revisiting the responses from the first round, we were able to obtain a more realistic measure of whether or not the majority of our participants agreed with the suggested implementations. The experts reviewed the summary of the data collected from their responses to the first round's survey and shared their opinions as to if they agreed or disagreed with the trends in the data.

The purpose of this stage was to narrow down the possible implementations of artificial intelligence in higher education through a survey given to the same type of experts who participated in the first round of the Delphi Study, with the goal of reaching consensus or divergence. Before the claims made in the first round of surveys were shared with the experts, we revisited each response given by the experts and identified topics that could lead to individual discussions amongst participants. Once the claims made by the panel of experts were arranged properly into the survey for the second round, we distributed the survey to the panel of experts. Each expert was presented with the relevant claims made by the experts in the first round of surveys. The experts were asked if they agree or disagree with each relevant claim and then they were asked to elaborate. This way, we were able to determine the experts' beliefs regarding implementing artificial intelligence in specific categories within higher education such as learning and instruction, enrollment student experience, etc. This round allows us to give arguments and counterarguments to experts participating in our third and final round of the Delphi Study.

3.23 Round 3

The goal of the third round was to produce consensus and divergence data regarding expert opinion on where artificial intelligence could have an impact on higher education institutions. The data collected in this round of the study was sent to administrative personnel at WPI so that they could provide feedback on the feasibility of incorporating ideas suggested by the AI experts.

In this round the participants were given several statements and asked to respond by indicating whether or not they agreed with the statement. The participants were given the options of “disagree”, “somewhat disagree”, “somewhat agree” and “agree”. After each statement the participants were given a space to give any additional notes that they had about the statement. The statements that were included in the third round were the statements that elicited response in the second round along with arguments for and against the statement from the second round. This way the third round provided a chance for any participants in the study to reconsider their viewpoints after hearing arguments made by other participants of the study. The categories of statements can be found in Table 1.

2030	2050
Learning and Instruction	Learning and Instruction
Student Experience	Student Experience
Athletics	
Facilities	

Table 1: Categories of Round 3 Statements

In addition to being asked to agree or disagree with expert predictions, the round three survey asked participants to rank which areas of higher education they believed would be most

affected by AI by the year 2030. The same question was asked about the year 2050. Participants were then asked if anything within the survey surprised them or gave them additional insight into how AI could impact higher education.

3.3 Feedback

After completing the Delphi Study we reached out to a different field of experts to examine the feasibility of implementing AI into higher education. The first form of feedback we created was a resource allocation grid based on the responses from the Delphi Study. We reached out to WPI administrators and staff to determine where they would invest resources into developing strategies for the use of AI. We chose these participants because they are experts on WPI. The second form of feedback we created was an opportunity for ethics experts to comment on the ideas that came out of our Delphi Study. We reached out to WPI ethicists to investigate some of the ethical concerns of implementing AI into higher education.

3.31 Resource Allocation

First, we presented WPI administrators and educators with a brief report summarizing our findings from the Delphi Study, as seen in Appendix C, to use as a guide in their decision of where to allocate resources.

We asked our participants to allocate resource points to the university categories that came out of our Delphi Study. These resource points represented how likely our participants were to invest their time and money into various areas of higher education. Participants were given the following list of higher education categories:

- Learning and Instruction
- Student Experience
- Enrollment
- Career Planning
- Facilities
- Athletics
- Other

The participants were then asked to create two resource allocation plans, one for 2030 and one for 2050. Similar to the Delphi Study, we chose the year 2030 to represent a close future goal that is realistic with today's technology. We chose the year 2050 to represent a more long term plan for AI in higher education.

The participants were given 100 points to distribute. They were asked to invest the 100 credits into the different areas listed. The participants were asked to invest all 100 credits in any way that they saw fit. They were not required to invest credits into all of the categories. The resource points represented how much emphasis WPI would hypothetically put on this area when implementing AI. Figure 3, below, shows the grid that participants used to allocate their points:

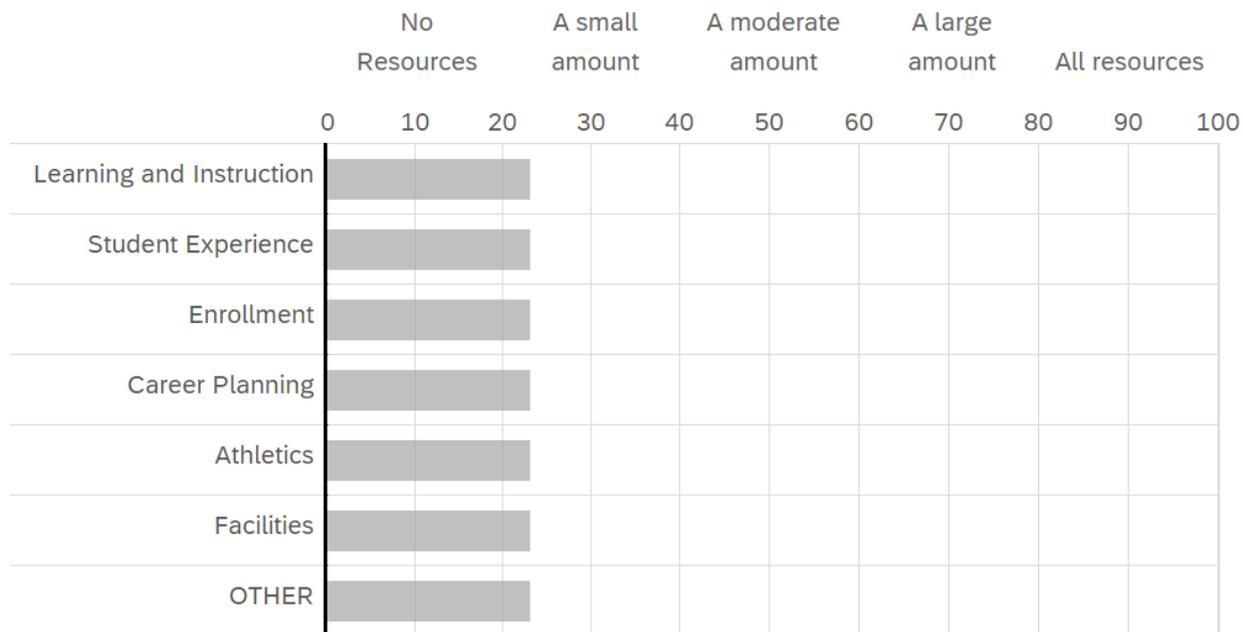


Figure 3: Grid Participants used during Resource Allocation

Each resource allocation plan was followed by an open response labeled as “optional notes” to give the participants a chance to explain their reasoning for their resources allocation. At the conclusion of the resource allocation round we asked the WPI administrators and educators if any of the data in the Delphi Study report surprised them or changed their mind.

3.32 Ethical Considerations

Similar to the resource allocation, we presented WPI ethicists with the report found in Appendix to use as a guide in ethical considerations.

We reached out to WPI ethicists via email to investigate some of the ethical concerns of implementing AI into higher education. We decided to reach out to these experts via email in order to make the feedback process as convenient as possible. We asked these ethics experts if they noticed any specific ethical concerns within the subcategories that we highlighted in the report.

We responded to these ethicists in a timely manner and asked for their preferred method of communication. We received one email response detailing the ethical dilemmas of our study. We set up one informational interview with an ethicist who was eager to provide us with more details in a more personal setting. During the informational interview, we asked follow up questions to the answers they provided about university subcategories.

4.0 FINDINGS

4.1 Findings Overview

In the following sections, we discuss the results from the Delphi Study and our Feedback Round. Each round is divided into a breakdown of the participants, and the findings from both the 2030 questions and the 2050 questions. We reported the categories that participants felt were most likely and least likely to be impacted by the implementation of AI. We will include samples of the thought provoking anonymous responses we received during this study. The concept map below shows an overview of the concepts that emerged from the Delphi Study.

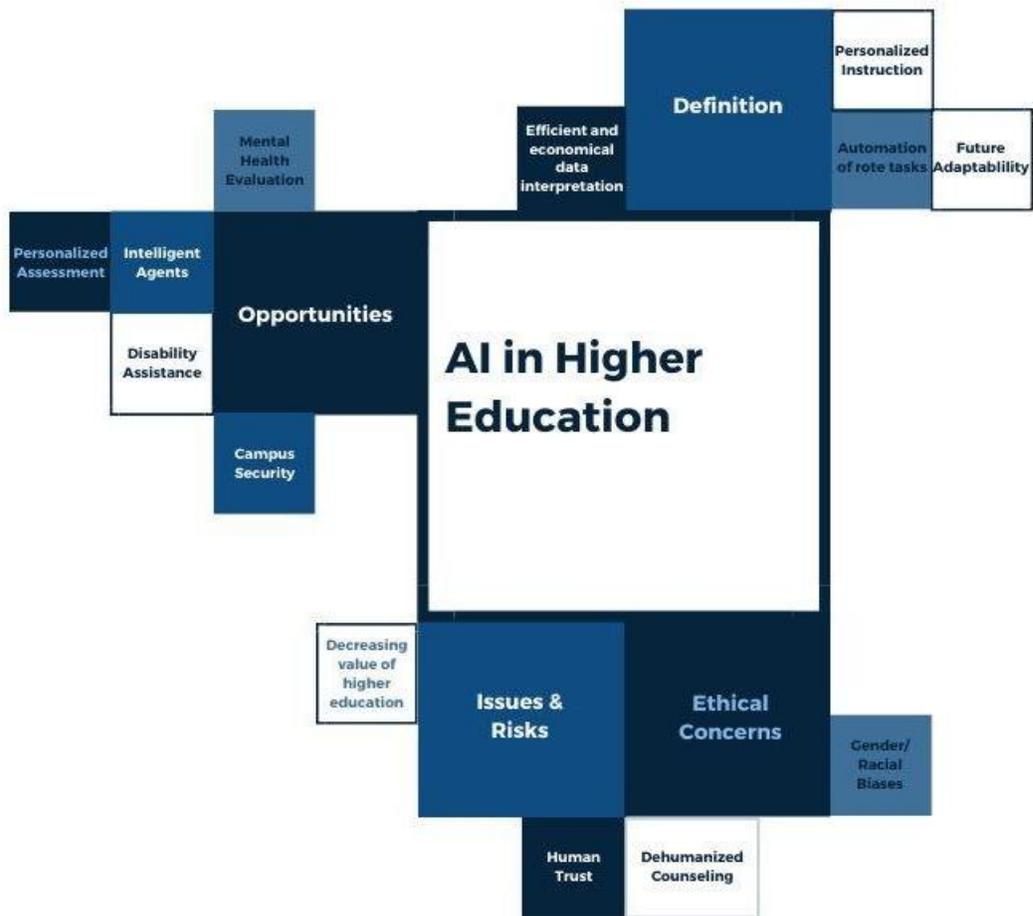


Figure 4: Concept Map overview of concept revealed during the Delphi Study

4.2 Round 1

Our Round 1 goal was to ask the participants to consider AI in higher education in the near and distant future. This was our brainstorming round, so we included as many opportunities for the participants to add their original thoughts as possible. Round 1 followed this overall structure:

1. Welcome Message
2. Informed Consent
3. Survey Questions
 - a. 2030
 - b. 2050

4.21 Participants

Eleven AI experts from industry and academia participated in our first round of our Delphi Study. The academic experts study Artificial Intelligence at the following universities: Worcester Polytechnic Institute, Massachusetts Institute of Technology, University of Massachusetts at Amherst, Arizona State University. The number of participants affiliated with each university is listed below in Table 2.

University Name	Number of Participants
Worcester Polytechnic Institute	5
Massachusetts Institute of Technology	2
University of Massachusetts at Amherst	1
Arizona State University	1
Not Specified	2
Total Participants	11

Table 2: Breakdown of Participants for Round 1

4.22 Round 1: 2030

In Round 1, we asked participants to indicate university areas that might be improved with Artificial Intelligence by 2030. We expected that it would be easier for our participants to visualize 2030, rather than 2050, because it is nearer in the future. We provided our participants with a list of areas we compiled from our background: Enrollment, Learning and Instruction, Student Experience, Athletics, Facilities, Personalized Career Planning, Research, and Other. For 2030,

Learning and Instruction and Student Experience were the most frequently chosen university categories. Personalized Career Planning and Athletics were the least frequently chosen categories, with 4 and 3 participants choosing them respectively. For 2030, we did not receive any open responses within the optional Other category. The results are shown below in Figure 5:

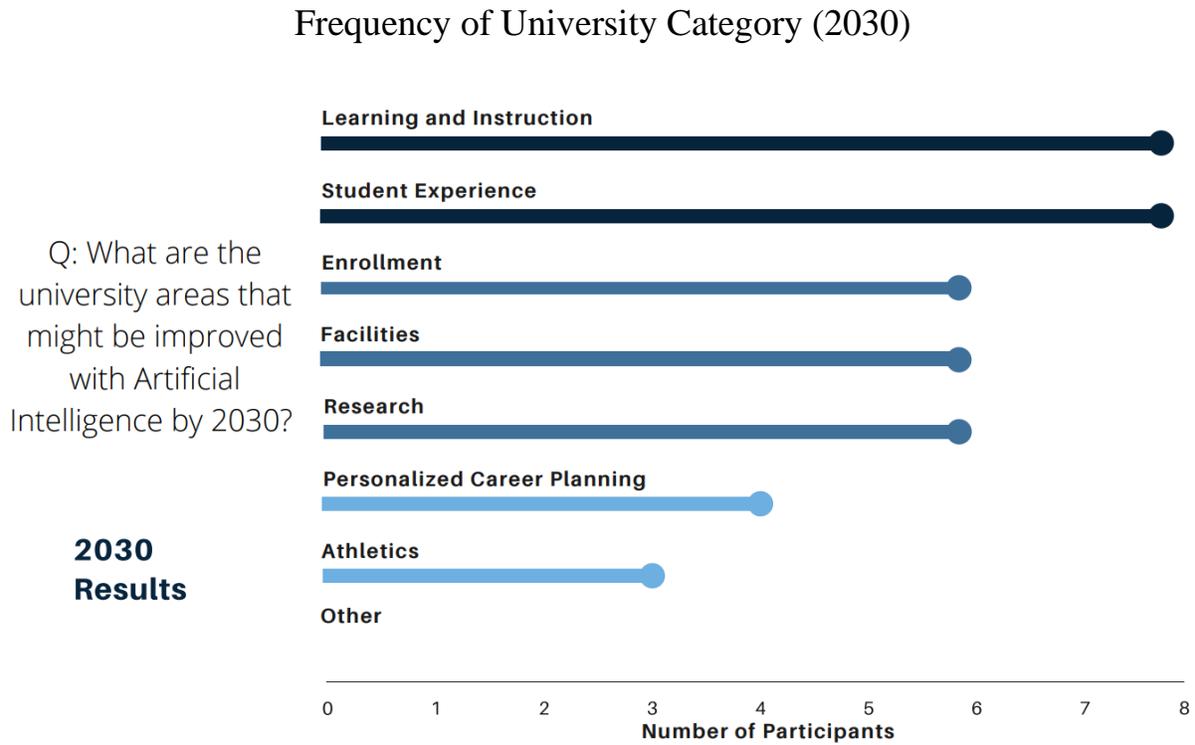


Figure 5: Number of Times each University Category was selected (2030)

In order to generate as many original ideas as possible, we asked our participants to fully explain why they selected the university areas above. We received the following explanations for our participants' 2030 predictions:

University Category	Participant Explanation
Enrollment Personalized Career Planning Facilities	“I see AI being able to give insight and help decision makers on a university campus (e.g. other qualities of potential students to accept/deny, helping students decide on a career path, notifying facilities where spills happen).”
Enrollment	“Enrollment can be maximized by better understanding the 'profile' of the student most likely to attend specific university”
Learning and Instruction	“Learning and instruction will benefit from preventative interventions for students who are on the verge of dropping or disconnecting from classes.”
Student Experience	“Student experiences - allowing for better connections between groups and patterns of social behavior.”
Personalized Career Planning	“AI can build multiple pathways that can help students understand the coursework / activities needed or used most in the profiles that most closely align with their intended profession.”
Student Experience	“As services like Amazon web server (AWS) continue to evolve and give easy access to some of the best machine learning models, universities will be able to use it to improve the students overall experiences.”
All	“All of these options are subject to advancements in machine learning to better understand and analyze the trends of data points across established models of 'effectiveness'.”

Table 3: Participant Responses explaining why they selected University Categories (2030)

The main trend within our participants’ 2030 reasons for selecting categories was the emergence of subcategories. Participants focused their examples on one or two specific applications within the university categories we presented to them.

4.23 Round 1: 2050

We asked participants to indicate which university areas that might be improved with Artificial Intelligence by 2050. We provided them with a list of areas we compiled from our background: Enrollment, Learning and Instruction, Student Experience, Athletics, Facilities,

Personalized Career Planning, Research, and Other. For 2050, Learning and Instruction and Student Experience were again the most frequently chosen university categories. Participants chose Personalized Career Planning and Athletics more frequently than in 2050. For the 2050 predictions, Personalized Career Planning and Athletics received 2 and 4 more votes than 2030, respectively. Enrollment and Facilities were mentioned less frequently in the 2050 predictions. For 2050, we did receive one optional Other response. The results are shown below in Figure 6:

Frequency of University Category (2050)

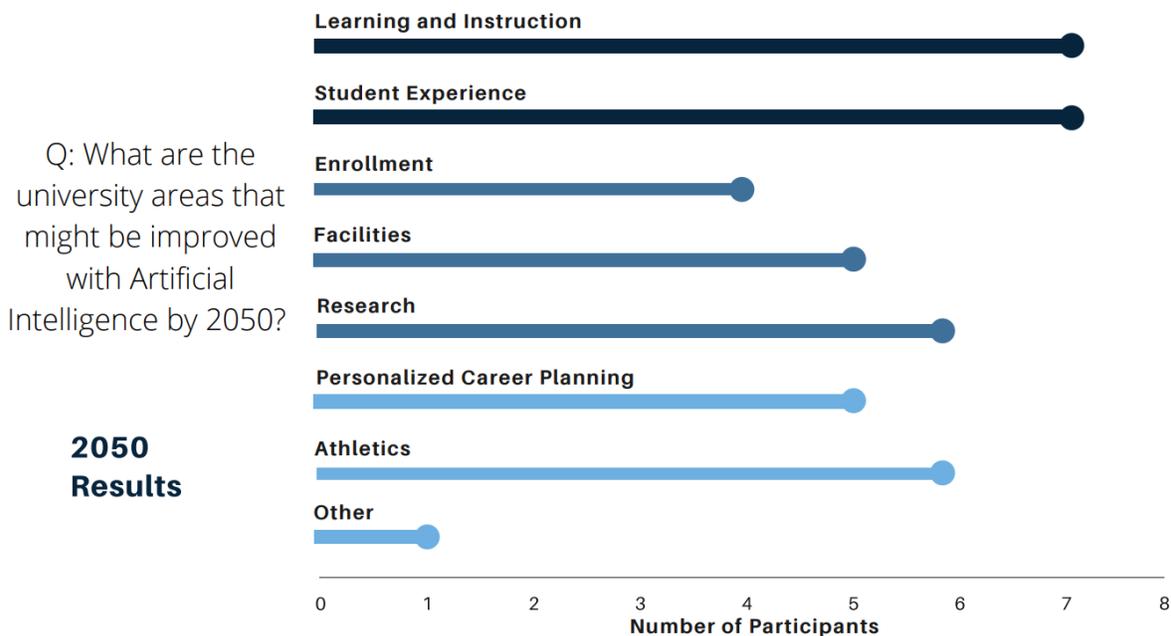


Figure 6: Number of Times each University Category was selected (2050)

For 2050, as seen in Figure 6, one of the participants selected Other. We received one qualitative response within the optional **Other** category: “Potentially almost any, as vision, speech, natural language understanding, robotics will all develop. Those 'abilities' can be put to use in many ways.”

In order to generate as many original ideas as possible, we asked our participants to fully explain why they selected the university areas above. We received the following explanations for our participants' 2050 predictions:

University Category	Participant Explanation
Learning and Instruction	“Augmented reality headsets, haptic devices for learning, etc will make it possible to access remote [learning], run experiments remotely, and conduct more immersive virtual office hours.”
Student Experience	“Technology that profiles and reacts to student stress, anxiety, and other conditions will be widespread. Virtual and physical ‘personal assistants’ might start to become common, to help with psychological issues, companionships, and social activities.”
Athletics	“Robotics and AI are already having impact, but by 2050 these technologies will both enhance performance and allow for efficient physical enhancement and recovery (think of exoskeletons).
Facilities	“Robots will be widely deployed to perform maintenance and repairs, allow for interactive virtual tours, help with emergency response, etc.”
None	“Hard to predict what will happen in 2050. All we know is that we will be surprised.”

Table 4: Participant Responses explaining why they selected University Categories (2050)

The main trend within our participants' 2050 reasons for selecting categories was the challenge of coming up with creative predictions for 2050. Many participants chose not to respond to this question. Participants who did respond focused their examples on one or two general applications within the university categories we presented to them.

4.3 Round 2

4.31 Participants

Participants included in this round of the Delphi Study included 30 experts of Artificial Intelligence at the following universities: Worcester Polytechnic Institute, Massachusetts Institute of Technology, Rochester Institute of Technology, Northeastern University, University of Massachusetts at Amherst, Carnegie Mellon University, and California Polytechnic State University. The number of participants affiliated with each university is listed below in Table 5.

University Name	Number of Participants
Worcester Polytechnic Institute	12
Massachusetts Institute of Technology	9
Rochester Institute of Technology	2
Northeastern University	2
University of Massachusetts at Amherst	2
Carnegie Mellon University	1
California Polytechnic State University	1
Not Specified	1
Total Participants	30

Table 5: Number of Experts Participating in Round 2

4.32 Round 2: 2030

In Round 2, we asked the participants to agree or disagree with the statements participants had made in Round 1 of the Delphi Study. We separated the statements made in Round 1 into categories and further broke it down into subcategories. We then asked the participants to examine the possibilities that each subcategory will become affected by AI by the year 2030 and either agree or disagree with the statement they were presented with. We also allowed the participants to comment after the categories and subcategories included in the 2030 part of Round 2, which are shown in Table 6 below.

Category	Subcategory
Learning and Instruction	Personalized Learning Material
	Intelligent Agents
	Online Courses
	Efficient Feedback
Enrollment	Targeted Recruitment
Student Experience	Mental Health Evaluation
	Counseling
	Career Planning
Athletics	Targeted Coaching
Facilities	Campus Security
	Facial Recognition

Table 6: Categories and Subcategories of 2030 Section of Round 2 Survey

After obtaining the results from Round 2, we assessed the responses and created a visual representation of the findings of each question to show how many participants agreed or disagreed with each statement. Please refer to Appendix C: Round 2 Detailed Report to review a breakdown from all responses from this round.

We created a summary report of the 2030 responses to show one example from each overarching university category. Our summary report for 2030 can be found below, in Figure 7.

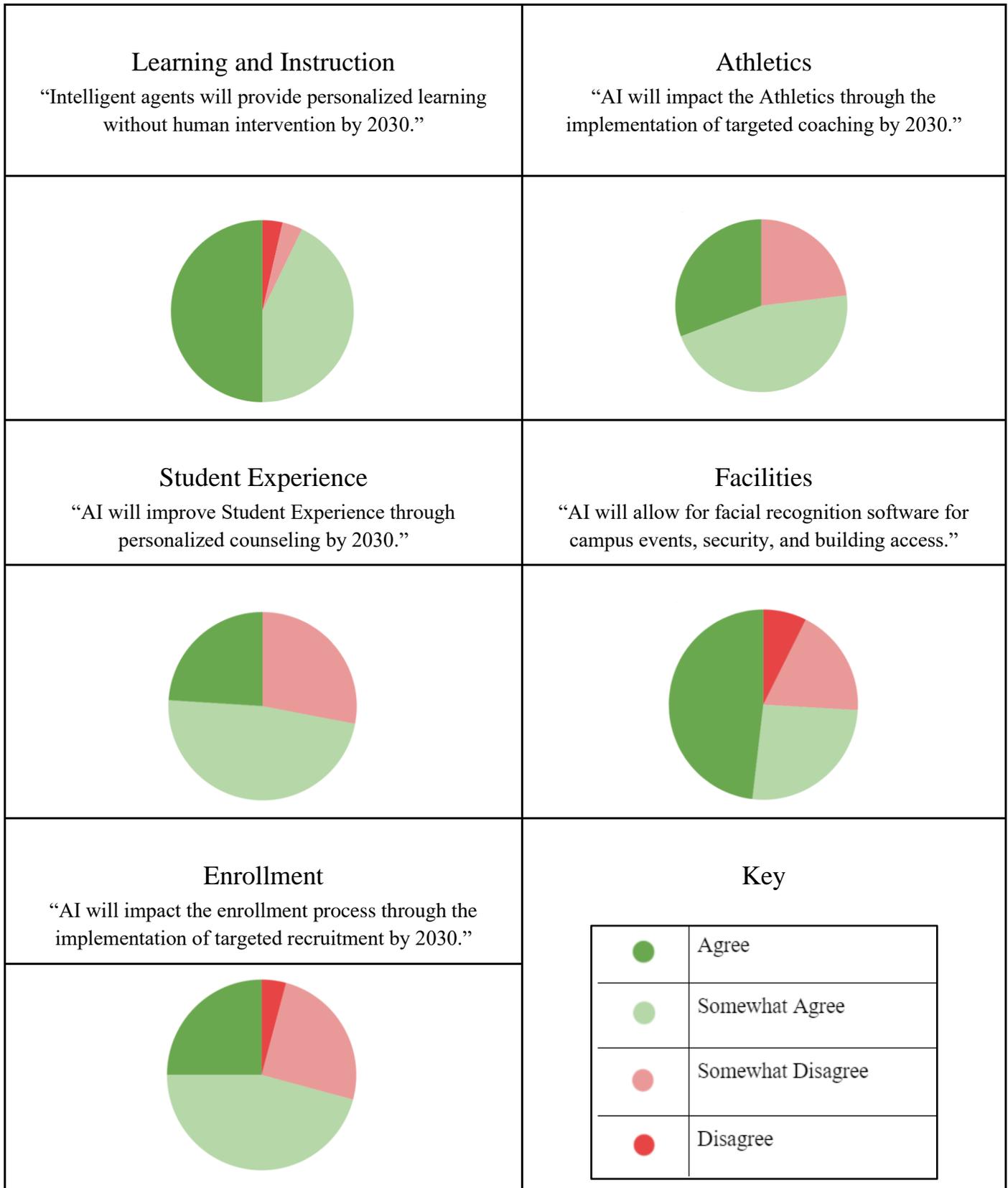


Figure 7: Visual Summary of Round 2: 2030 Findings

Learning and Instruction

As shown above, about 93% of survey participants either agreed or somewhat agreed that intelligent agents will provide personalized learning without human intervention by 2030. About 7% of participants disagreed or slightly disagreed with this statement.

Athletics

Within the Athletics category, the majority of the survey participants agreed or somewhat agreed that AI could lead to personalized targeted coaching by 2030. Although the majority of the responses were positive, about 23% of participants slightly disagreed. Of the participants who slightly disagreed, one participant noted: “Ai is currently focused on cognitive abilities. More research is needed to enable AI to help improve physical training”.

Student Experience

As shown in the figure above, the majority of the survey participants agreed or partially agreed that intelligent agents could provide counseling to students and faculty/staff for emotional challenges and cessation behaviors. 28% of participants slightly disagreed. Of those who disagreed, one participant noted privacy concerns: “HIPPA/Privacy concerns may impede progress here”.

Facilities

As shown in the figure above, the majority of the survey participants agree or somewhat agree that AI systems will be deployed for facial recognition software for campus events, security, and building access.

Although the majority of the responses were positive, about 26% of participants disagreed or slightly disagreed. Of the participants who disagreed, one noted privacy concerns surrounding AI in campus security: “I believe there will be backlash for using such privacy-

invading technologies by universities, even if they are commonly used”. Another participant predicted that the AI capabilities will simply not be there by 2030: “I don't see facial recognition being that good in 10 years to use it for something mission critical”.

Enrollment

As shown in Figure 7, there was some variance with all choices being represented. The majority of survey participants somewhat agreed with the statement presented. There were also 25% of participants agreeing and another 25% somewhat disagreeing with the statement. This shows that there was a large number of participants somewhat agreeing with the statement that claimed AI will impact targeted recruitment in higher education by 2030.

4.33 Round 2: 2050

We then asked the participants to examine the possibilities that each subcategory will become affected by AI by the year 2050 and either agree or disagree with the statement they were presented with. We also allowed the participants to comment after the categories (and subcategories) included in the 2050 part of Round 2, which are shown in Table 7 below.

Category	Subcategory
Learning and Instruction	Online Courses
	Contextually Relevant Universities
	Up-Skilling of Employees
Student Experience	Disability Assistance
Facilities	Maintenance and Repairs
Academic Integrity	Cheating

Table 7: Categories and Subcategories of 2050 Section of Round 2 Survey

We created a summary report of the 2050 responses to show one example from each overarching university category that appeared in the 2050 questions. Our summary report for 2050 can be found below, in Figure 8.

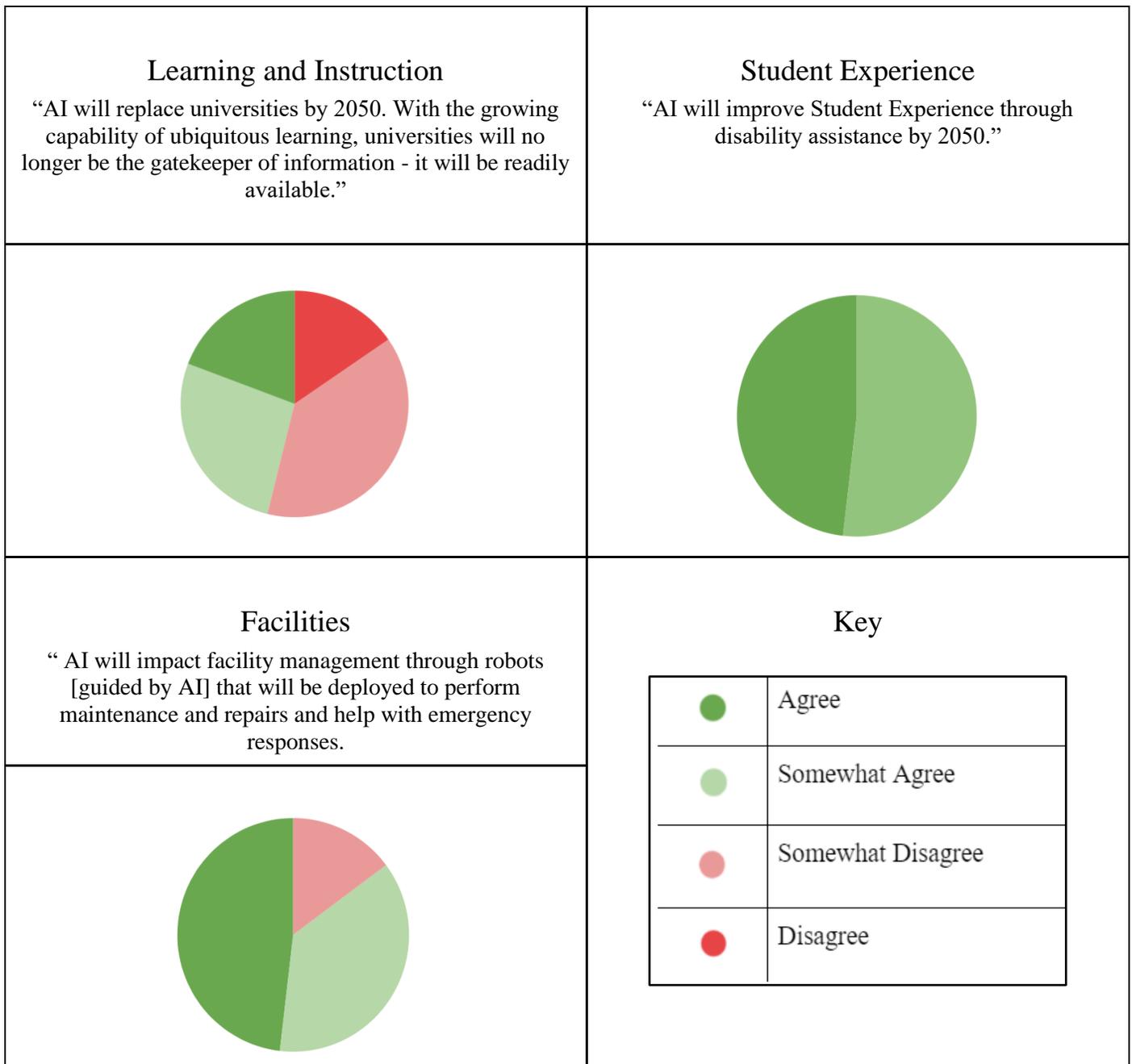


Figure 8: Visual Summary of Round 2: 2050 Findings

Learning and Instruction

As shown above, there was a lot of divergence with all answer choices being represented. The responses are split up somewhat evenly across all four potential answer choices. However, the most popular answer was somewhat disagree with approximately 39% of survey

participants somewhat disagreeing with the statement explaining how AI could replace contextually relevant universities by the year 2050. In the optional notes section, many of our participants noted that the community value of a university can never be replaced.

Student Experience

As shown in the figure above, all of the survey participants either agree or somewhat agree that there could be an implementation of AI through disability assistance by the year 2050. There were no negative responses to the statement presented.

Facilities

As shown in the figure above, the majority of the survey participants were on the positive side of the scale, either agreeing or somewhat agreeing that AI will impact facilities management through maintenance repairs and emergency responses. A total of 85% of participants were on the positive side of the scale, either agreeing or somewhat agreeing with the statement presented. Although the majority of the responses were positive, there were about 15% of participants who responded negatively to the statement, however none fully disagreed with this statement.

4.34 Round 2: 2030 vs. 2050

After analyzing the results we obtained from Round 2 of our Delphi Study, we compared the results from 2030 to the results from 2050 from the common categories between the two parts. For example, we compared what experts had to say about online courses in 2030 to what they had to say about them in 2050. The two subcategories that overlapped in the 2030 section and 2050 section are online courses in learning and instruction and campus maintenance in facilities. We

directly compared how many experts agreed, somewhat agreed, somewhat disagreed, and disagreed with the statements presented to them in the 2030 section and in the 2050 section.

In Figure 9, below, the responses regarding the increasing trends of online courses are shown. As you can see, there were more experts who agreed that this could be implemented in 2050 rather than 2030. More experts fully agreed with the statement in 2050 compared to their responses in 2030 where the majority of experts only somewhat agreed. Overall, there were less experts who's 2050 response was on the disagree side of the scale compared to their responses for 2030. Although there were no experts who fully disagreed, there was an overall change to the positive side of the scale when changing 2030 to 2050.

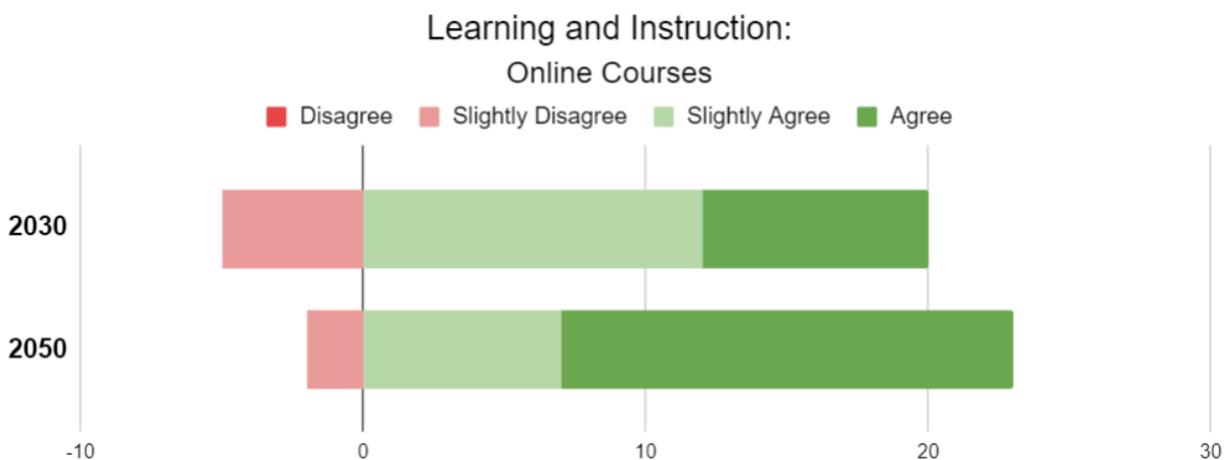


Figure 9: Learning and Instruction: Online Courses Prediction 2030 vs. 2050

The responses regarding implementation of AI through campus maintenance are shown in Figure 10 below. Similarly to the figure above, there were more experts who agreed that this could be implemented in 2050 rather than 2030. In the 2030 section, a few experts fully disagreed in addition to the ones who somewhat disagree. However, when presented with the same statement for 2050, the total number of experts who were on the disagree side of the scale decreased when

compared to the amount from 2030, with no experts fully disagreeing with the statement presented. Although the amount of experts who agreed with the statement for 2030 stayed approximately the same for 2050, the overall amount of experts on the agree side of the scale increased while the amount of experts on the disagree side of the scale decreased.

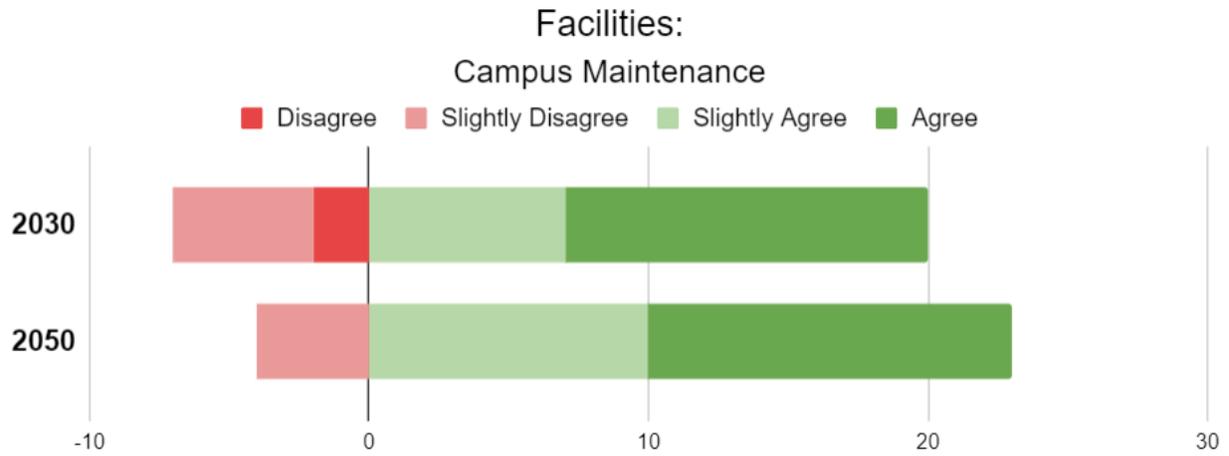


Figure 10: Facilities: Campus Maintenance Prediction 2030 vs. 2050

4.4 Round 3

4.41 Participants

Eleven participants, including participants from Worcester Polytechnic Institute, Massachusetts Institute of Technology, and University of Massachusetts at Amherst completed the Round 3 survey. The distribution of participants for round 3 is shown below.

University Name	Number of Participants
Worcester Polytechnic Institute	2
Massachusetts Institute of Technology	5
University of Massachusetts at Amherst	2
Not Specified	2
Total Participants	11

Table 8: Number of Experts Participating in Round 3

4.42 Round 3: 2030

In Round 3, we asked the participants to agree or disagree with the statements participants had made in Round 2 of the Delphi Study. Participants were given statements that supported or opposed each subcategory. Participants were then asked if they “agree”, “somewhat agree”, “somewhat disagree”, or “disagree” with each statement. This gave the participants the option to change their minds about if each subcategory will become affected by AI by the year 2030 after being presented with opposing viewpoints. We also allowed the participants to comment after the categories (and subcategories) included in the 2030 part of Round 2, which are shown in Table 9 below.

Category	Subcategory
Learning and Instruction	Online Courses
	Efficient Feedback
Student Experience	Counseling
	Career Planning
Athletics	Targeted Coaching
Facilities	Campus Security

Table 9: Categories and Subcategories of 2030 Section of Round 3 Survey

After obtaining the results from Round 3, we assessed the responses and created a visual representation of the findings of each question to show how many participants agreed or disagreed with each statement. Please refer to Appendix G: Round 3 Detailed Report to review a breakdown from all responses from this round.

We created a summary report of the 2030 responses to show one example from each overarching university category. Our summary report for 2030 can be found below, in Figure 11a and 11b.

Key

	Agree
	Somewhat Agree
	Somewhat Disagree
	Disagree

Figure 11a: Visual Summary of Round 3: 2030 Findings Key

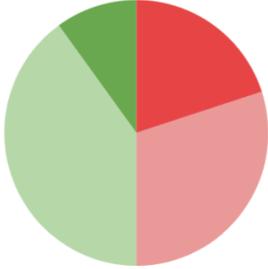
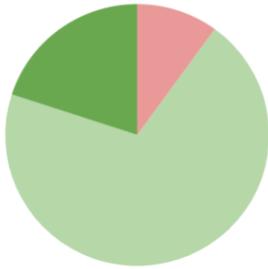
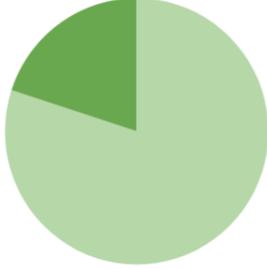
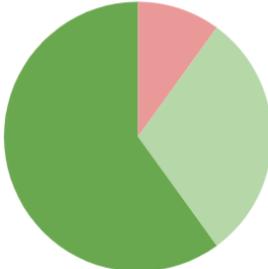
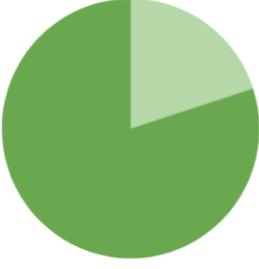
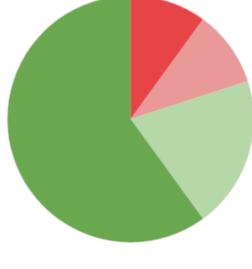
<p>Learning and Instruction Efficient Feedback “Algorithms will dictate how grades are given out. I don't think learning criteria will change.”</p>	<p>Learning and Instruction Online Courses “By 2030, new organizations such as edX or Coursera might displace some of what current universities do.”</p>
	
<p>Student Experience “Intelligent agents could be available to provide counseling to students and faculty/staff for emotional challenges and cessation behaviors.”</p>	<p>Athletics “AI [could] get the raw data that would allow the personalized coaching. [This could involve] Cameras everywhere that could see the swing? The kick?”</p>
	
<p>Facilities “A potential detriment of [facial recognition] to watch is the unintended consequences of a surveillance state”</p>	<p>Facilities Campus Security: Feasibility “Facial recognition for campus events, security, and building access are all feasible predictions for 2030.”</p>
	

Figure 11b: Visual Summary of Round 3: 2030 Findings

Learning and Instruction

As shown above, within the subcategory Efficient Feedback, participants were split on whether algorithms will determine how grades are given out in 2050 with 50% of participants either agreeing or somewhat agreeing and 50% of participants disagreeing or somewhat disagreeing.

Within the subcategory Online Courses, almost all of the participants agreed or somewhat agreed that certain new institutions might replace some of what colleges do by 2030, with 90% of participants agreeing or somewhat agreeing.

Student Experience

As shown within the Counseling subcategory, 100% of participants felt that intelligent agents would be able to provide counseling for emotional challenges and troubling behaviors by 2030. We had some comments that even though the capabilities will be there, they might not be widely used.

Athletics

As shown above, a large majority of participants felt that the necessary data could be collected for AI to be used for personalized coaching with 90% of participants either agreeing or somewhat agreeing.

Facilities

Within the Campus Security: Privacy Concerns subcategory, 100% of participants agreed that the use of AI for facial recognition could lead to the unwanted consequence of a surveillance state. Agreement with this and the next statement indicates that experts may feel facial recognition

could but shouldn't be used, or they realize there are problems with facial recognition despite its advantages.

Within the Campus Security: Feasibility subcategory, the majority of participants felt that AI could be used for facial recognition software for things like event security and building access by 2030 with 80% of participants agreeing or somewhat agreeing.

4.43 Round 3: 2050

We then asked the participants to examine the possibilities that each subcategory will become affected by AI by the year 2050 and either agree or disagree with the statement they were presented with. We also allowed the participants to comment after the categories (and subcategories) included in the 2050 part of Round 3, which are shown in Table 10 below.

Category	Subcategory
Learning and Instruction	Relevance of Traditional Universities
	Social Value of Higher Education
	Academic Integrity
Student Experience	Disability Assistance

Table 10: Categories and Subcategories of 2050 Section of Round 3 Survey

We created a summary report of the 2050 responses to show one example from each overarching university category. Our summary report for 2050 can be found below, in Figure 12.

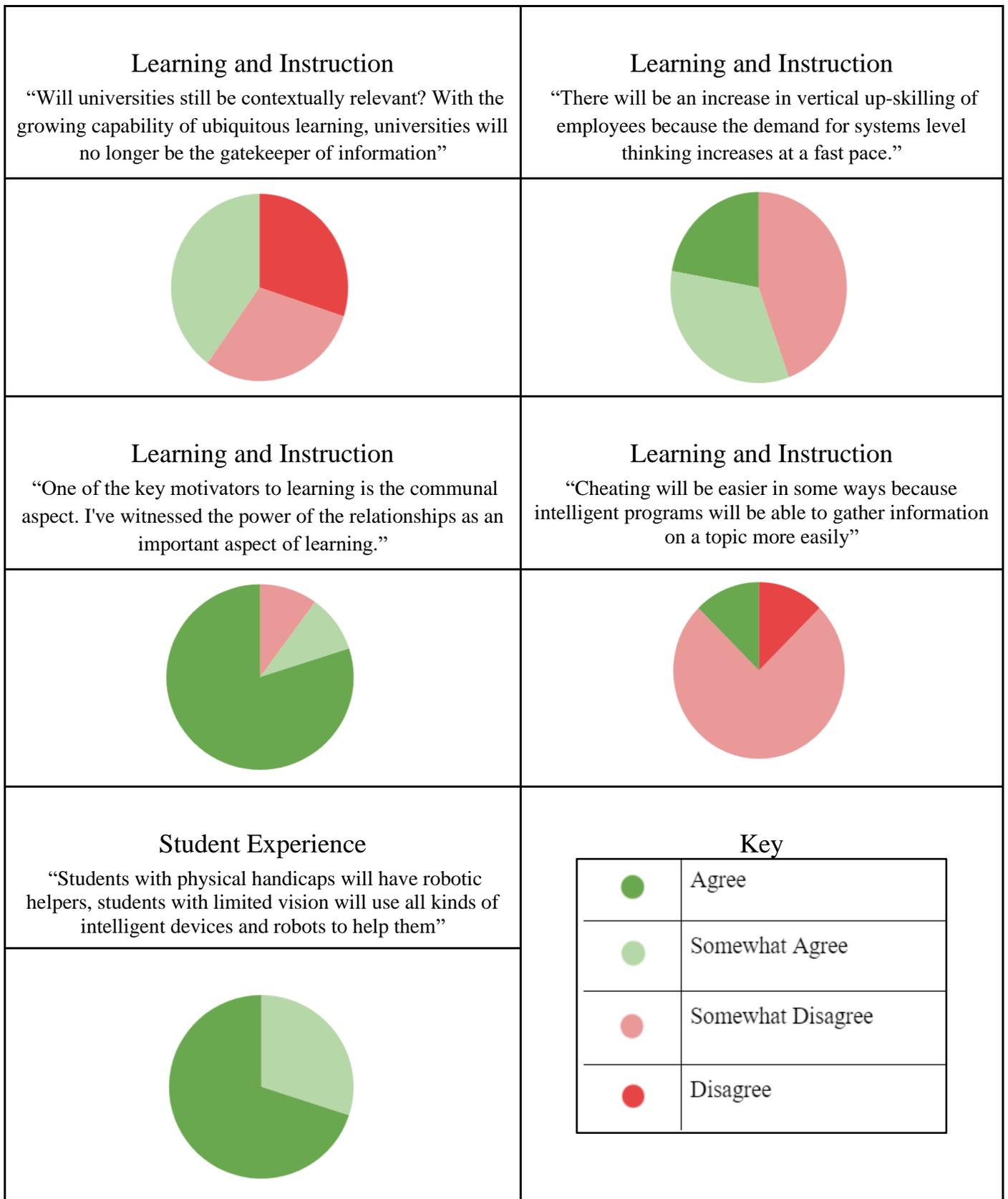


Figure 12: Visual Summary of Round 3: 2050 Findings

Learning and Instruction

As shown above, within the subcategory Relevance of Universities, participants were split on whether or not universities would still be relevant or the gatekeepers of information by 2050 with 60% disagreeing or somewhat disagreeing and 40% somewhat agreeing. This may indicate that some participants disagree about universities losing relevance but agreeing with the statement that they will not be the gatekeepers of information.

Within the subcategory Upskilling of Employees, the majority of participants felt that there would be an increase in vertical upskilling by 2050 with 67% agreeing or somewhat agreeing and 33% somewhat disagreeing.

In the Social Value of Higher Education subcategory, the majority of participants agree that one of the key motivators for learning is the communal aspect including relationships formed between students and teachers, with 90% agreeing or somewhat agreeing.

In Academic Integrity, the majority of participants felt that cheating would not be easier by 2050 because of the aid of AI with 87% of participants disagreeing or somewhat disagreeing. Of the participants who disagreed, one noted:

“Real learning is not about gathering information. It is about knowing how to use the information. By 2050 we should be better at devising assignments and assessments that evaluate the learning, rather than just the accumulation of facts. That will make cheating more difficult.”

Student Experience

As shown above 100% of participants either agreed or slightly agreed that by 2050, intelligent agents and robots will be able to assist students with physical disabilities.

4.44 Round 3: 2030 vs. 2050

For the third round, we asked the participants to rank the areas of higher education that they believed would be impacted the most by higher education. We found that the same three categories were ranked most likely to be impacted by AI in the 2030 and 2050 rounds. These categories were Data Analysis, Learning and Instruction, and Enrollment. Additionally, we found the two categories the participants ranked as least likely to be impacted by AI were the same in 2030 and 2050. These categories were Athletics and Facilities. Career Planning and Student Experience filled the middle of the rankings. The average rankings for both 2030 and 2050 are shown below in Figure 13.

2030		2050	
Rank	Category	Rank	Category
1	Data Analysis	1	Data Analysis
2	Learning and Instruction	2	Learning and Instruction
3	Enrollment	3	Enrollment
4	Career Planning	4	Student Experience
5	Student Experience	5	Career Planning
6	Athletics	6	Athletics
7	Facilities	7	Facilities

Figure 13: 2030 vs. 2050 Rankings of Importance

4.5 Feedback

4.51 Participants

We asked approximately 45 staff members of Worcester Polytechnic Institute to provide feedback on our study. The main differences between this feedback section and our previous Delphi Study is that we included no Artificial Intelligence experts in this survey and every respondent is from WPI. Participants included education management, admissions, department heads of popular majors, student activities, facilities, and athletics.

WPI Area of Expertise	Number of Participants
Education Management	3
Admissions	3
Student Activities	1
Facilities	2
Athletics	3
Total Participants	12

Table 11: Resource Allocation Participants

4.6 Resource Allocation

We asked participants to make a resource allocation plan for the years 2030 and 2050. We provided the participants with a brief overall report of the results from our previous surveys. In Appendix C: The Round 2 Detailed Report represents the information on the overall report including the AI expert predictions from the first two rounds of our study. Using the expert AI predictions from the overall report, we asked the participants to allocate points based on how they

would distribute resources to create the best AI plan for 2030 and then the same for 2050. We instructed the participants to give the most amount of resources to the areas that they deemed most important for AI to become involved in. The percentage of resources that each category received represents how much emphasis that they would put on this area for its importance in the future of AI in higher education. In Appendix H: The Feedback Survey shows the formal layout of our survey. The areas participants could allocate resources towards were

- Learning and Instruction
- Student Experience
- Enrollment
- Career Planning
- Athletics
- Facilities
- OTHER

These are the areas that Artificial Intelligence experts from all over the world deem most important in the future of higher education AI. We asked participants to keep in mind the goal of our study: to increase WPI's competitive standing in 2030 and 2050 through the successful implementation of AI.

4.61 2030 Resource Allocation

In the 2030 resource allocation, we asked our participants to use the brief overall report and their knowledge of WPI to allocate resource points to the university categories that emerged from our Delphi Study. Figure 14, below, represents the results from the 2030 resource allocation question.

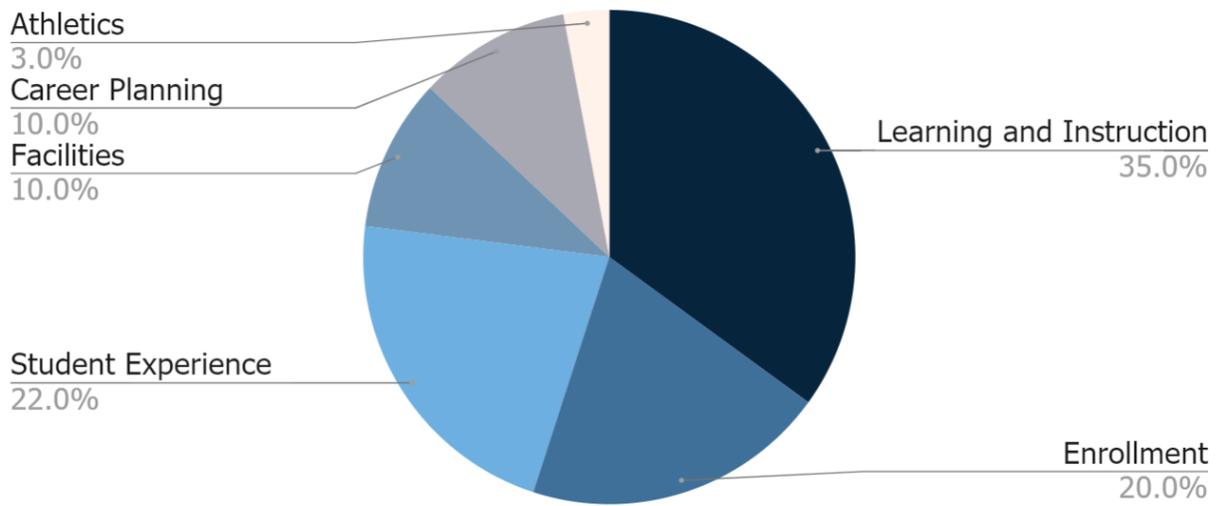


Figure 14: 2030 Resource Allocation Plan Visualization

Learning and Instruction had the majority of focused resources and received 35% of all resources for the year 2030. The resources represent how important the participant believes this category is. Based on these results, we can assume that Learning and Instruction and Student experience are the most important areas of focus when it comes to implementing AI into higher education, both categories take over 50% of resources for 2030. Athletics, facilities and career planning received the least amount of resources with a combined total of less than 25%. This is consistent with the results of our Delphi Study, which was portrayed on the Overall Report that we presented in this round. It is worth noting that WPI as an institution has a reputation of immersive student experience and cutting edge learning and instruction. In keeping with this reputation, WPI is more likely to put their resources into these areas, rather than athletics which is not a main focus of the university.

Participants also had the opportunity to add additional notes explaining their decisions for the resource allocation plan. “I believe the student experience can sell itself, and therefore does

not require as much AI.” said one participant. The findings from the resource allocation for 2030 follow the trend of the previous study findings, learning and instruction dominated most conversation over the course of the Delphi Study.

4.62 2050 Resource Allocation

In the second question, we asked our participants to allocate resources for 2050. We reminded participants that we chose the year 2050 to represent a future goal where the bounds of technology are unrestricted. This year allowed our participants to use their own creativity to answer the question about where AI will go in the future. Figure 15, below, represents the results from the 2050 resource allocation question:

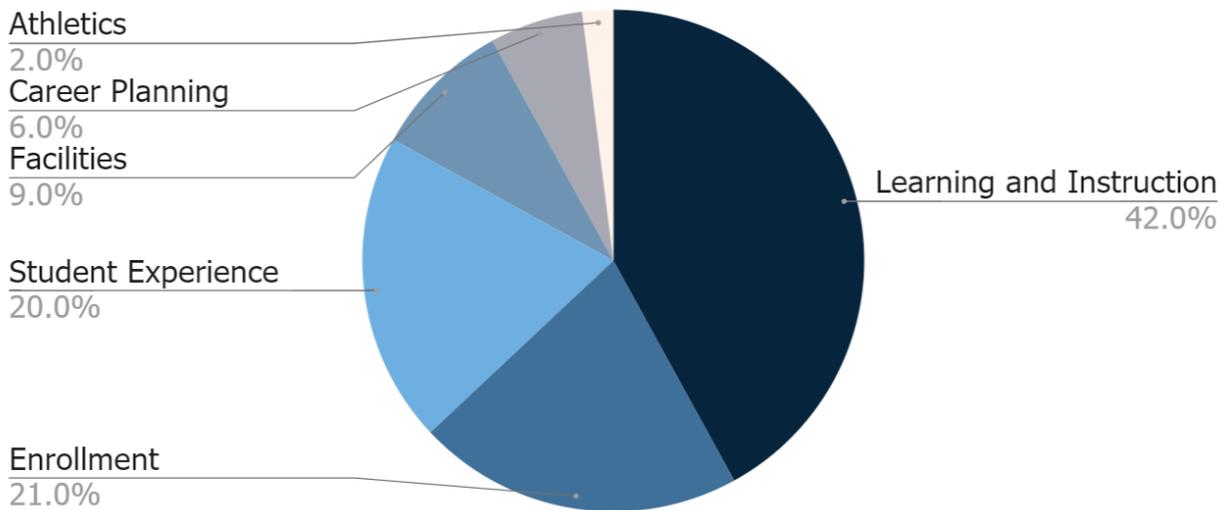


Figure 15: 2050 Resource Allocation Plan Visualization

Learning and Instruction was the clear leader and used 42% of resources for the year 2050. The resources represent how important the participant believes this category is. Based on these results, we can assume that Learning and Instruction and Student experience are the most important areas of focus when it comes to implementing AI into higher education. The main difference

between 2030 and 2050 findings is the decrease in resource allocation towards student experience. For the year 2050 there were more resources allocated toward learning and instruction, almost 50% of all resources would be used towards learning and instruction. This shows the importance that this category represents in overall AI implementation into higher education.

The participant also had the opportunity to add additional comments to the survey. “Very helpful to think about spreading the use of AI over different parts of the enterprise, and over different time horizons.” said one participant. Another participant noted that they allocated resources very similarly between years. “I think I'm surprised by how similar I felt I ranked items in each scenario (2030 and 2050).” This is worth paying attention to considering the unpredictable nature of the year 2050 as the future of AI.

4.8 Framework of Categories

The following list represents the University Categories revealed during this Delphi Study. These are the areas that Artificial Intelligence (AI) experts that we surveyed from across the country deem most important in the future of higher education AI:

- Learning and Instruction
 - Intelligent Agents
 - Efficient Feedback
 - Performance Evaluation
 - Personalized Learning Material
 - Online Courses
- Student Experience
 - Social Value of Higher Education
 - Mental Health Evaluation
 - Counseling
 - Career Planning
 - Disability Assistance
- Enrollment
 - Targeted Recruitment
 - Financial Aid Decisions
- Athletics

- Personalized Physical Enhancement
- Facilities
 - Campus Security
 - Facilities Maintenance

5.0 DISCUSSION

The following section will analyze the findings from our series of surveys. We will discuss our observations, such as advantages and disadvantages of implementing Artificial Intelligence in different areas of higher education, for both 2030 and 2050. The analysis and explanations behind survey responses will also be explored in more depth. We will look at any outliers we discovered, in addition to common trends in predictions of AI implementations in Higher Education. We will also look further at the Resource Allocations that were provided by Worcester Polytechnic Institute administration and staff. The final deliverable of our recommendation to WPI Administration will conclude this section, included with a look at recommendations for other Higher Education Institutions and possible future research in this area.

5.1 2030 Discussion

Across all rounds of the Delphi Study, we had more responses from the 2030 rounds than the 2050 rounds. Most of these 2030 responses were also far more detailed than the 2050 responses. Our participants may have found it easier to visualize 2030 because their view of the near future looks similar to the present, with more technological advancements. AI experts noted that many of the technologies they mentioned already exist in some way. Participants might have had the most predictions in Learning and Instruction and Student Experience because these are the areas where AI exists already. One AI expert noted that the Computer Science department at their university already employs intelligent agents for grading coding projects. Another participant noted that AI already plays a role in counseling and supporting students to improve their student experience. The current pandemic has revealed that AI chatbots are already capable

of performing telehealth. For 2030, our participants used current AI applications to guide their predictions.

After reviewing our findings, seeing that Learning and Instruction, Student Experience, and Enrollment were some of the most frequently predicted university categories was encouraging as in our prior research, we found that “only 60% of students at 4 year colleges graduated within 6 years of beginning their enrollment” (The Condition of Education). All three of these areas can have a large impact on retention rates. When a university supports its students in both their learning experience and overall wellbeing, students may be more likely to complete their degree. From another perspective, if a school succeeds in enrolling students who show signs of adapting well to their university, they may increase their retention rate as well.

5.2 2050 Discussion

Due to our own predictions that the survey participants will have an easier time making predictions for 2030 versus 2050, we were expecting the data collected for 2050 to be more obscure than the data regarding 2030. Because 2050 seemed so far in the future, the data collected (in the sections pertaining to 2050), from the AI experts participating in the Delphi Study, was more scattered than the data collected in the 2030 section of the surveys. Some artificial intelligence experts stated that it was hard to predict what could happen in regards to the future implementations of artificial intelligence because a lot can happen in the next 30 years and it is hard to visualize it, as it may have not been thought of yet. Other experts have noted that robotics and artificial intelligence is not advanced enough and need to overcome hurdles allowing major breakthroughs before they could predict what can happen by 2050.

After obtaining this feedback from the first round of the Delphi Study, we slightly altered the way we asked them for their opinions. Rather than asking them to be as detailed as possible

with their response, we simply asked them to be as creative as possible. This allowed them to think more innovatively than logically. We were looking to explore all potential options when it came to the implementation of artificial intelligence in higher education and therefore, we needed as many thoughts, ideas, and opinions on the topics presented as possible. From this alteration, it seemed as though the experts were able to think more innovatively rather than logically, which provided more futuristic data in each round of the Delphi Study. The more thought provoking data we collected, the more indepth our surveys could be, which could also provoke more ideas from the experts in later rounds.

When the participants were asked their opinions for each category and subcategory of higher education and how AI could be implemented into each of them, there was consensus and divergence around certain topics. For example, the most consensus was formed around the implementation of AI in the category of student experience through disability assistance, in which all experts either agreed or somewhat agreed. The most divergence was formed around the claim that AI could replace contextually relevant universities by 2050. The responses were somewhat evenly split between agree, somewhat agree, somewhat disagree, and disagree. This shows that there are many conflicting opinions as to whether or not AI could replace universities by 2050. Participants seemed to be split in that while they agreed that universities may no longer be gatekeepers of information by 2050 (some argued that they are no longer gatekeepers of information currently) almost all of our participants felt that universities will still be relevant due to the social nature of humans and the role of universities as places for pushing the boundaries of knowledge.

5.3 Resource allocations

Our Resource Allocation survey was answered by a total of 12 participants. These participants included WPI Administration, Department Heads, Admissions, Student Activities, Facilities and Athletics staff. Each participant is well versed in their respective field at WPI and has worked with resource allocation in their career. The percentage of resources that each category received represents how much emphasis the participants would hypothetically put on this area for its importance in the future of AI in higher education.

In this section we will review the results from the resource allocation survey and what those results mean to our study as a whole. We will be discussing specific resource allocation, additional comments from participants, and the average resource allocation that came out of this survey.

In Appendix H: Feedback Survey, you can see the set up of our Feedback Survey to WPI Administration and Staff. The survey was composed of a resource allocation grid for 2030, 2050 and space for additional comments after each grid. One participant, said

“My large commitment to enrollment has been influenced by [WPI’s] Project Center-Student Placement software. Frankly, I prefer to interview students but the software has made reasonable allocations. I can imagine admissions offices using similar technologies to select students and pursue them until enrollment.”

This participant used their prior information on placement software to dictate their decisions on the Resource Allocation for 2030. This indicates the importance that Enrollment has in the future of AI implementation, within the selection process specifically. Using previous

software that is already used within Admissions and Enrollment, Artificial Intelligence can be implemented in ways to further improve the way that Universities admit new students.

Another comment within the 2030 Resource Allocation came from a participant who said,

*“I believe the student experience can sell itself,
and therefore does not require as much AI.”*

This participant believes that Student Experience at WPI does not need the implementation of Artificial Intelligence to improve. This is a distinct divergence from most of the responses we received from this survey. It is important to note that although this participant does not believe that Student Experience needs the implementation of AI, they allocated 20% of resources to that category. This amount of resources is on trend with the other participants from this survey. This may indicate that Student Experience is a top area of Higher Education that can be improved by AI, despite what the comment by this participant says. However it is an important note that not everyone agrees about the use of AI in higher education. Despite the information the participants were given, the participants had their own opinions and viewpoints that they acted on.

Another participant included the following comment at the conclusion of the study,

*“I think the Delphi folks are too sanguine about the role of AI
in Instruction. I think there'll be more on-line instruction but one of the areas
that resist most technology substitution is the desire for face-to-face
contact between teachers and students. It is a deeply human encounter,
though not as personally interactive as, say, love making,
but still much prized as a one-to-one encounter”*

Participant Z put approximately 10% of resources towards Learning and Instruction, which is lower than the average for both the years 2030 and 2050. This comment is an example of

divergence from the Artificial Intelligence Experts that participated in our Delphi Study. Seemingly, Participant Z's problem with AI implementation is the absence of a human encounter between teacher and student. It is worth noting that AI experts in our Delphi Study predicted AI impacting online courses as well as intelligent agents and personalized learning materials to make Learning and Instruction more personalized for each student. It is also worth noting that some AI experts in our Delphi Study felt that human to human interaction is necessary in higher education. This is a split topic amongst experts, so it is an important insight to give WPI when discussing our recommendations. Although online courses do not encompass face to face contact, other implementations of AI in Learning and Instruction keep the human encounter intact, and add AI to other aspects of the lesson.

The results from the 2030 Resource Allocation plan indicate that Learning and Instruction is considered the most important category of Higher Education to implement Artificial Intelligence in order to increase WPI's competitive standing against other Universities. It is worth noting that currently WPI is most well known for their immersive classroom experience and the unique student experience. This may indicate a special interest in these areas for WPI Administration and Staff to further benefit their reputation in Learning and Instruction and Student Experience. Similarly, WPI has a NCAA Division III Athletics program, and puts significantly less emphasis on this area than other Universities such as institutions that have NCAA Division I Athletics programs and can further build their reputation in Athletics. Athletics' low rank amongst WPI Administration and Staff might indicate that improving athletics is not instrumental in increasing WPI's competitive standing against other Universities. Based on the results from the Resource Allocation plan for 2030, we can assume that WPI Administration would be most likely to implement AI into Learning and Instruction, Student Experience and Enrollment.

The results from the 2050 Resource Allocation plan indicate that Learning and Instruction is considered the most important category of Higher Education to implement Artificial Intelligence in order to increase WPI's competitive standing against other Universities. Similarly to the Resource Allocation plan for 2030 the top three results are the same. Based on the results from the Resource Allocation plan for 2050, we can assume that WPI Administration would be most likely to implement AI into Learning and Instruction, Student Experience and Enrollment. Due to the similarity between the years 2030 and 2050, we can assume that any ideas for implementation in 2050 should be implemented in the year 2030. As Artificial Intelligence changes and evolves, the allocations for the year 2050 may change.

The resource allocation plans follow closely with the results from our Delphi Study with AI experts. This may indicate that administration at WPI agrees that the implementation of AI in Learning and Instruction and Student Experience will have the biggest impact on WPI's competitive standing against other universities. AI implementation is a relatively new field of research, especially within Higher Education. If WPI is on the front of implementation of AI, it could significantly impact their reputation as a modern STEM institution.

5.4 Limitations of the Study

One limitation our study suffered from is having less than the ideal number of responses for the first and third round. More responses could have aided the first round where the participants brainstormed categories of higher education that AI could impact. With more participants more categories may have been generated. To combat this problem, the round 2 and 3 surveys contained open response questions where participants could mention any other categories of higher education they felt may be impacted. In order to increase the number of participants our Delphi Study only included individuals who were considered experts in AI, it was not limited to individuals with a

joint knowledge of AI and higher education administration. Many of our experts likely do not have extensive knowledge of the inner workings of higher education institutions. There could be processes in higher education that would be vastly improved with the use of AI that the participants in our study were unaware of.

Additionally, our study was completed entirely online. While this was acceptable for a Delphi study, had a study involving in person interactions been possible, a method of study that allowed for more immediate feedback may have been used.

5.5 Ethical Considerations



Figure 16: Word Cloud representation of Ethicist Feedback

Please refer to Figure 16, above, for a visual summary of the words and concepts that arose during our ethical feedback round. Despite the potential of Artificial Intelligence to impact higher

education for the better, it is not without its flaws. While the AI experts included in our Delphi Study have knowledge about the shortcomings and weaknesses of AI they are not all experts in the ethical dilemmas that the use of AI brings about. In order to ensure that our report for WPI on how to implement AI took these ethical concerns into consideration we interviewed two ethicists about worries that they had regarding the implementation of AI into higher education.

One of the first concerns that was mentioned was that of biases present in AI. It was pointed out to us that AI will commonly pick up any biases present around it. These often take the shape of gender or racial biases. This can be a problem in a field such as enrollment where selecting which students to target with an AI can be heavily biased by factors unrelated to their ability to succeed. One ethicist interviewed stated “And so, if I think about who does very well at WPI AI and what type of students that we tend to attract and what type of student we struggled to retain, the AI will identify white middle class men [as the students we should try to attract].” An AI would be unable to take different privileges students may have had into consideration when determining what type of students were most likely to be successful.

Another major concern was that of privacy and data ownership. In order for universities to use AI for various processes of higher education a large amount of data is required. To get this data universities would have to collect it from students. It is possible that universities could use the data that they have already collected from students such as medical and academic records without getting the permission of students. Even if universities do seek student permission before using their data it brings up the question of who now owns that data and who, if anyone, should be allowed to monetize it. It is also possible that universities are hacked leading to the leaking of private student information such as medical records.

Additionally in the field of privacy are concerns regarding facial recognition software. People do not have the ability to change their face so if this facial recognition data is misused or hacked, there is nothing that can be done to remedy the problem. Facial recognition also requires cameras which have the potential of leading to a surveillance state that impedes individuals freedoms.

AI can also have several negative ramifications if applied to the idea of students' mental health and well being. Mental health issues can often be worsened by a feeling of disconnect or isolation from those around you. To have these feelings and to then seek help only to be sent to an AI rather than a person could make these feelings worse or more severe rather than help to alleviate them. Having AIs in the field of mental health could also make it more difficult for an individual to reach a mental health care professional when they really need them. AIs are also created under the assumption that humans are rational beings and that there is a logic behind their actions. This is often not the case as humans act on emotion as well as reason. This can cause AIs to be ineffective for predicting or adjusting human behaviors.

Another problem created by AI is the possible stifling of innovation. AI based education is driven by attempting to bring all students closer to a defined standard. That standard does not always represent the best possible outcome.

6.0 CONCLUSION

In this section we will summarize the findings we obtained from our Delphi Study, review the ethical concerns presented with using AI in higher education, and make recommendations for WPI to improve using AI. After conducting the Delphi Study, analyzing the results, and speaking with ethicists, we were able to understand some of the possible impacts AI can have on higher education in the near and distant future.

In the 2030 portion of the Delphi Study, the emphasis was on the implementation of AI in learning and instruction and student experience. Other topics included enrollment, facilities, and research, with the least emphasis on personalized career planning and athletics. We found that most experts believe that the implementation of classroom aids, such as intelligent agents, could be implemented in higher education by the year 2030. Some had even said that some universities are already in the preliminary stages of implementations. Another topic of discussion included how instructors could use a form of AI that could help with grading projects and assessments. Again, some experts have noted that some universities have already implemented this. Other areas of discussion included the increasing implementation of existing trends of online courses and personalized learning material, however, both topics did not have as large of a consensus as the former topics. In the category of student experience, the majority of experts agree both mental health evaluations and counseling through the implementation of AI could be used in higher education. Most of the experts agreed with the idea of these implementations, however, there were uncertainties when it came to executing the ideas into an everyday lifestyle in higher education. One of the main concerns that the experts had was how little time there was to implement these ideas in 10 years. Some experts believe that AI is not that far along and will not be able to perform as well as we think.

In the 2050 portion of the Delphi Study, the emphasis was again on the implementation of AI in learning and instruction and student experience. Other topics explored were research, athletics, facilities, personalized career planning, and enrollment, in descending order of topics of discussion. Although there was consensus around the idea of increasing trends in online courses and the implementation of disability assistance by 2050, there was more variation with the predictions for 2050 especially in learning and instruction, where more experts disagreed that AI could replace universities by the year 2050. Experts believed that the value of an in-person education is much more valuable than an education that is completed fully online. There were also some concerns with an increasing rate of cheating by the year 2050. These concerns were not shared by the majority of participants. Overall, the predictions were more theoretical as we asked participants to think more creatively when answering our questions regarding the implementation of AI in higher education by the year 2050.

Ethicists believe that there are two main concerns when it comes to implementing AI in higher education. Their two main concerns were regarding data ownership and security. If universities collect data on students in order to create AIs that improve various processes in higher education, this creates questions about who owns the data that the universities collected and what they should be allowed to do with it. Do the universities then own the data and should they be allowed to monetize it? For security concerns, in both our Delphi Study and talks with ethicists it was mentioned that many problems surrounding privacy must be addressed before AI could be used for something like facial recognition for security access.

Our recommendations we derived from this study are based on the expert opinions we obtained from our Delphi Study, administrative opinions (specifically at WPI) from the resource allocation round, and ethicists' concerns from the ethical consideration round. We recommend that

WPI invest most of its AI resources into Learning and Instruction, specifically looking into Personalized Learning Material and Intelligent Agents. We also recommend an investment in Student Experience, specifically focusing on how AI can provide disability assistance. We also recommend that for the time being WPI refrain from investing resources into developing AI to use for security until privacy concerns can be fully addressed. Finally, we noticed that the 2030 and 2050 results were quite similar across the board. This could indicate that AI is coming sooner rather than later and that WPI would hold the best competitive advantage if it invests resources in AI by 2030. It is worth noting that our recommendations for WPI may not be the same recommendations we might make for other universities.

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Appendix A: Round 1 Survey

Welcome!

Welcome to our survey. We would like to thank you for taking the time to participate in our series of surveys.

Study Purpose: We would like to know how experts in the field of AI would allocate resources to different aspects of higher education.

We are asking you to use your expertise to create two suggested resource allocation plans:

- one for the year 2030
- one for the year 2050

This study will take place over three weeks.

Participation involves:

- Three Qualtrics Surveys (approximately 10-15 minutes each to complete)
 - **Round 1:** Brainstorm different higher education sectors that might be improved with AI.
 - **Round 2:** Determine where AI can have the highest impact on higher education institutions based on responses from Round 1.
 - **Round 3:** Respond to the reports created from the previous rounds.

Survey Contents

- Informed Consent Agreement
- Questions regarding impact of AI in 2030
- Questions regarding impact of AI in 2050

Round 1 Welcome Message

Round 1 Survey Questions: Page 1

1. [Open Response]

How might Artificial Intelligence (AI) capabilities change universities by 2030?

2. [Check boxes]What are the university areas that might be improved with Artificial Intelligence [by 2030] ?

- Enrollment
- Learning and instruction
- Student experience
- Personalized career planning
- Athletics
- Facilities
- Other

3. If you selected “OTHER” in the previous question, please name the university areas. If you would like to specify more than one unlisted university area, please separate your choices with a comma.

4. Using the university areas you selected above for 2030, please **fully explain** why you selected these options.

Round 1 Survey Questions: Page 1

Round 1 Survey Questions: Page 2

1. [Open Response]

How might Artificial Intelligence (AI) capabilities change universities by 2050?

2. [Check boxes]What are the university areas that might be improved with Artificial Intelligence by 2050?

- Enrollment
- Learning and instruction
- Student experience
- Personalized career planning
- Athletics
- Facilities
- Other

3. If you selected “OTHER” in the previous question, please name the university areas. If you would like to specify more than one unlisted university area, please separate your choices with a comma.

4. Using the university areas you selected above for 2020, please **fully explain** why you selected these options.

Round 1 Survey Questions: Page 2

Appendix B: Round 2 Survey

Welcome!

Thank you so much for taking our survey! This study will help us fulfill our degree requirement at Worcester Polytechnic Institute (WPI). We will use this data to make recommendations to WPI based on the potential impacts of Artificial Intelligence on higher education.

This survey will take an estimated **5-10 minutes**. The survey contains anonymous predictions about Artificial Intelligence (AI) in higher education in 2030 and 2050 from previous survey participants.

We will ask you to agree or disagree with these participants to the best of your ability. There will be an optional open response question at the end of each section as an opportunity for you to express your original thoughts and insights. Thank you!

Round 2 Welcome Message

Informed Consent Agreement for Participation in a Research Study

Please read the attached informed consent and agree to the terms below to continue with this survey.

Informed consent

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

Round 2 Informed Consent

You will be presented with predictions about the following categories:

- Learning and Instruction
- Enrollment
- Student Experience
- Career Planning
- Athletics
- Facilities
- Data Analysis

Please Agree or Disagree with the predictions to the best of your ability. For example, a statement may predict that universities will be obsolete by 2050. Please agree if you think this is an accurate prediction or disagree if you think that it is not.

You will have the option to write your thoughts in an [Optional notes] text box after each prediction.

You will have the opportunity to add your original predictions after each section, and again at the conclusion of the survey.

Round 2 Instructions

Round 2 Survey Questions: Page 1

[Checkboxes]

Learning and Instruction

2030 Predictions:

Personalized Learning Material

“Customized learning/curricula catered to providing students with questions or prompts that respond to individual weaknesses or cater to personal interests”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Checkboxes]

Intelligent Agents

“There could be Intelligent Tutors (i.e. computer system that provides personalized learning without human intervention) for some classes by 2030.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Checkboxes]

Online Courses

“Increase existing trends in online education, such as consolidation around more powerful universities”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Checkboxes]

Efficient Feedback

“Automated grading and assessment to provide much faster feedback.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Open Response]

Are there any other areas of **Learning and Instruction** that may be impacted by AI by 2030? Please be as creative as possible with your response.

Round 2 Survey Questions Page 1

Round 2 Survey Questions: Page 2

[Checkboxes]

Learning and Instruction
2050 Predictions:

Online Courses

[Checkboxes]

“Enhanced online learning with various telepresence devices that augment the learning experience [that may] run experiments remotely, and conduct more immersive virtual office hours”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Checkboxes]

“Will universities still be contextually relevant? With the growing capability of ubiquitous learning, universities will no longer be the gatekeeper of information - it will be readily available.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Checkboxes]

“In the technology and other related industries we expect to see a dramatic increase in vertical up-skilling of employees as the demand for systems level thinking increases at a pace traditional

higher education institutions cannot keep.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]
Optional Notes

[Open Response]
Are there any other areas of **Learning and Instruction** that may be impacted by AI by 2050?
Please be as creative as possible with your response.

Round 2 Survey Questions Page 2

Round 2 Survey Questions: Page 3

[Checkboxes]

Enrollment **2030 Predictions:**

Targeted Recruitment

“The initial screening of college applicants giving them scores based on an algorithmic evaluation of that prospective student, establishing models of 'successful candidates' based on trained behavior and performance, and not limited to the traditional mindset of 'college preparedness’”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]
Optional Notes

[Open Response]
Are there any other areas of **Enrollment** that may be impacted by AI by 2030? Please be as creative as possible with your response.

Round 2 Survey Questions Page 3

Round 2 Survey Questions: Page 4

[Check Boxes]

Student Experience

2030 Predictions:

Mental Health Evaluation

“Technology that profiles and reacts to student stress, anxiety and other conditions. Virtual and physical "personal assistants" might start to become common, to help with psychological issues, companionships, and social activities”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Checkboxes]

Counseling

“Intelligent agents (on screen or on a cell phone or whatever devices we have in 10 years) could be available to provide counseling to students and faculty/staff for emotional challenges and cessation behaviors (smoking cessation, etc).”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Open Response]

Are there any other areas of **Student Experience** that may be impacted by AI by **2030**? Please be as creative as possible with your response.

Round 2 Survey Questions: Page 5

[Check Boxes]

Student Experience

2050 Predictions:

Disability Assistance

“Students with physical handicaps will have robotic helpers, students with limited vision will use all kinds of intelligent devices and robots to help them”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Open Response]

Are there any other areas of **Student Experience** that may be impacted by AI by **2050**? Please be as creative as possible with your response.

Round 2 Survey Questions Page 5

Round 2 Survey Questions: Page 6

[Check Boxes]

Career Planning

2030 Predictions

Alumni Matching

"[AI could] help to match students with alumni who match the student's interests, profile and interests"

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Open Response]

Are there any other areas of **Career Planning** that may be impacted by AI by 2030? Please be as creative as possible with your response.

Round 2 Survey Questions Page 6

Round 2 Survey Questions: Page 7

[Check Boxes]

Athletics

2030 Predictions

Targeted Coaching

"[AI] could lead to personalized, targeted coaching"

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

Are there any other areas of **Athletics** that may be impacted by AI by 2030? Please be as creative as possible with your response.

Round 2 Survey Questions Page 7

Round 2 Survey Questions: Page 8

[Check Boxes]

Facilities

2030 Predictions

Campus Security

"Additionally, the use of AI systems will be deployed across non-academic elements as well, in terms of usage of facial recognition software for campus events, security, and building access"

- Disagree
- Somewhat Disagree

- Somewhat Agree
- Agree

[Open Response]
Optional Notes

"A potential detriment of [facial recognition] to watch is the unintended consequences of a surveillance state"

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]
Optional Notes

[Open Response]
Are there any other areas of **Facilities** that may be impacted by AI by **2030**? Please be as creative as possible with your response.

Round 2 Survey Questions Page 8

Round 2 Survey Questions: Page 9

[Check Boxes]

Facilities

2050 Predictions

Facilities Maintenance

"Robots will be deployed to perform maintenance and repairs, it will allow for virtual and interactive tours, help with emergency responses, etc."

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Open Response]

Are there any other areas of **Facilities** that may be impacted by AI by **2050**? Please be as creative as possible with your response.

Round 2 Survey Questions Page 9

Round 2 Survey Questions: Page 10

[Check Boxes]

Academic Integrity
2050 Predictions

Cheating

"Cheating will be in certain ways easier because intelligent programs will be able to gather information on a topic more easily"

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Open Response]

Are there any other areas of **Academic Integrity** that may be impacted by AI by **2050**? Please be as creative as possible with your response.

Round 2 Survey Questions Page 10

Round 2 Survey Questions: Page 11

[Open Response]

Did anything in this survey surprise you or change your mind? Do you have any new insights after reading these responses? Please be as specific as possible.

Round 2 Survey Questions Page 11

Appendix C: Round 2 Detailed Report

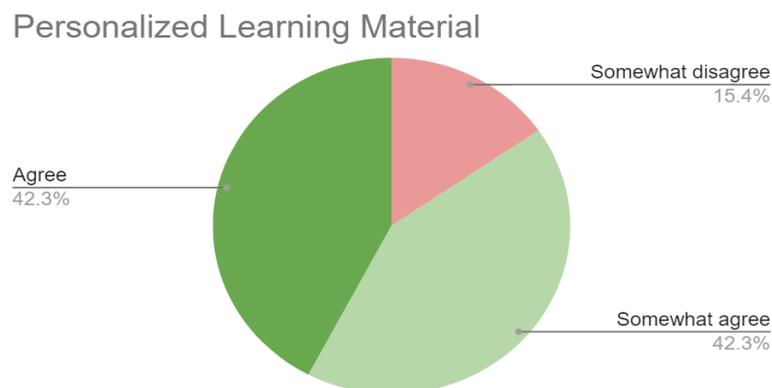
After obtaining the results from the 2030 section of Round 2, we assessed the responses and created a visual representation of the findings of each subsection to show how many participants agreed or disagreed with each statement. The detailed Round 2 Findings can be seen below.

Category: Learning and Instruction Subcategory: Personalized Learning Material

Experts predict that AI will impact Learning and Instruction in higher education by 2030. We first asked the participants to agree or disagree with this statement:

“AI will impact Learning and Instruction through customized learning/curricula catered to providing students with questions or prompts that respond to individual weaknesses or cater to personal interests.”

The distribution of responses are shown below.

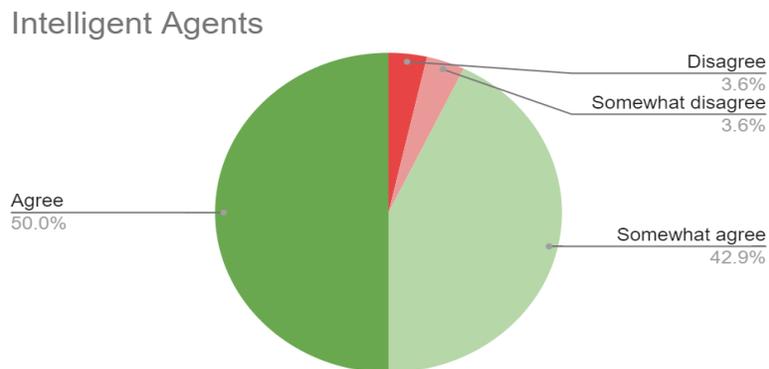


As shown in the figure above, the majority of the survey participants were on the positive side of the scale, either agreeing or somewhat agreeing with the statement presented to them. Although the majority of the responses were positive, there were about 15% of participants who responded negatively to the statement, however none fully disagreed with this statement.

Subcategory: Intelligent Agents

We then asked the participants to agree or disagree with this statement:

“One way that AI will impact Learning and Instruction is through the implementation of intelligent agents (i.e. computer systems that provide personalized learning without human intervention).”

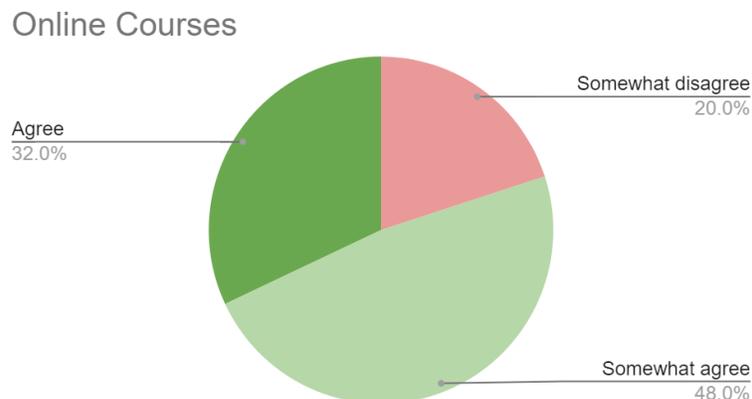


As shown in the figure above, there was some variance with all choices being represented. The majority of survey participants either agreed or somewhat agreed with the statement presented. 50% of participants agreed that intelligent agents could be implemented in higher education by the year 2030. This shows that most of the experts predict that intelligent agents could be implemented in higher education by 2030.

Subcategory: Online Courses

Next, we asked the participants to agree or disagree with the following statement:

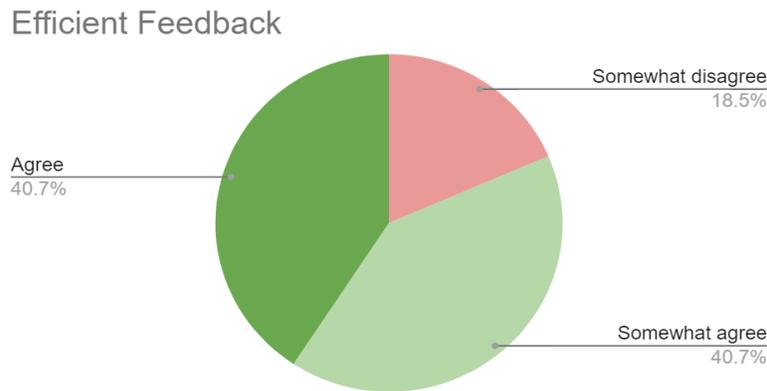
“AI will impact Learning and Instruction by increasing existing trends in online education, such as consolidation around more powerful universities.”



The majority of survey participants either agreed or somewhat agreed that AI will increase existing trends in online education by 2030. Although the majority of the responses were positive, 20% of participants slightly disagreed. Of those participants who disagreed, one noted some inadequacy of online learning and instruction: “Online courses only go so far. They lack the ability to enable scholarly discourse about a topic”.

Subcategory: Efficient Feedback

We then asked the participants to agree or disagree with the following statement: “AI will impact Learning and Instruction through the implementation of automated grading and assessment to provide much faster feedback.”



The majority of survey participants either agreed or somewhat agreed that the implementation of automated grading and assessment will provide much faster feedback by 2030. Of the participants who agreed, one noted their current use of AI in efficient feedback: “We already use automated grading in many of our CS classes, so this is a no-brainer”.

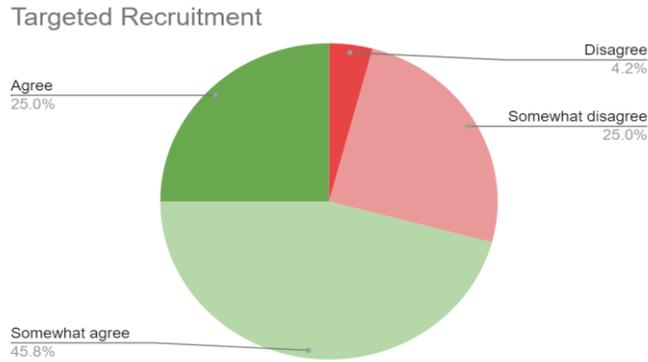
Although the majority of the responses were positive, about 18% of participants slightly disagreed. Of the participants who slightly disagreed, one noted “I suspect automated grading could do a better job in many fields, but social acceptance is the limiting factor -- not the AI”.

Category: Enrollment

Subcategory: Targeted Recruitment

Experts predict that AI will impact Enrollment in higher education by 2030. We asked the participants to agree or disagree with this statement:

“The initial screening of college applicants giving them scores based on an algorithmic evaluation of that prospective student, establishing models of ‘successful candidates’ based on trained behavior and performance, and not limited to the traditional mindset of ‘college preparedness.’”

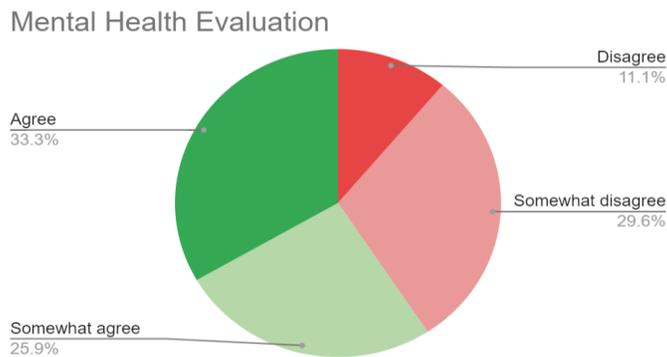


As shown in the figure above, there was some variance with all choices being represented. The majority of survey participants somewhat agreed with the statement presented. There were also 25% of participants agreeing and another 25% somewhat disagreeing with the statement. This shows that there was a large amount of participants somewhat agreeing with the statement that claimed AI will be implemented through targeted recruitment in higher education by 2030.

Category: Student Experience

Subcategory: Mental Health Evaluation

Experts predict that AI will impact Student Experience through Mental Health Evaluation in higher education by 2030. We asked the participants to agree or disagree with this statement: *“AI will impact Student Experience through implementations of technology that profiles and reacts to student stress, anxiety and other conditions. Virtual and physical ‘personal assistants’ might start to become common, to help with psychological issues.”*

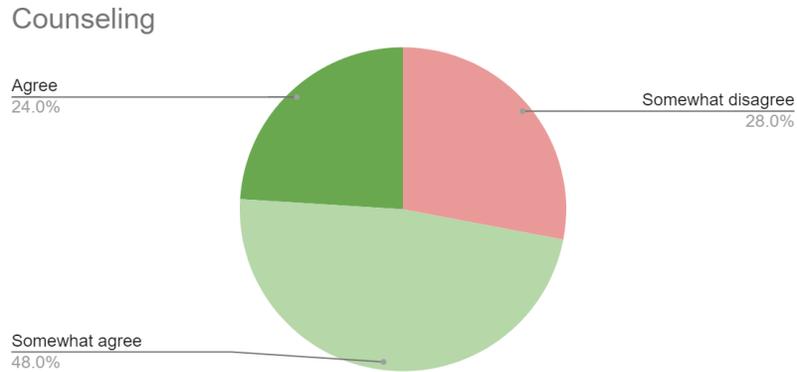


As shown in the figure above, there was some variance with all choices being represented. This showed the most variance in the 2030 portion of the Round 2 survey. The most survey participants (33.3% of participants) agreed that AI could be implemented to impact student experience through mental health evaluations by 2030. This shows that this specific topic could be worth discussing as there are many conflicting viewpoints.

Subcategory: Counseling

Experts predict that AI will impact Student Experience through Mental Health Evaluation in higher education by 2030. We asked the participants to agree or disagree with this statement:

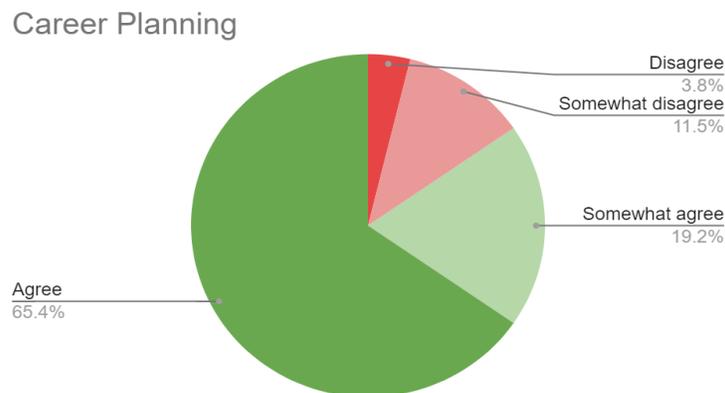
“AI will impact Student Experience through implementations of intelligent agents (on screen or on a cell phone or whatever devices we have in 10 years) could be available to provide counseling to students and faculty/staff for emotional challenges and cessation behaviors (smoking cessation, etc.).”



As shown in the figure above, the majority of the survey participants agreed or partially agreed that intelligent agents could provide counseling to students and faculty/staff for emotional challenges and cessation behaviors. 28% of participants slightly disagreed. Of those who disagreed, one participant noted privacy concerns: “HIPPA/Privacy concerns may impede progress here”.

Subcategory: Career Planning

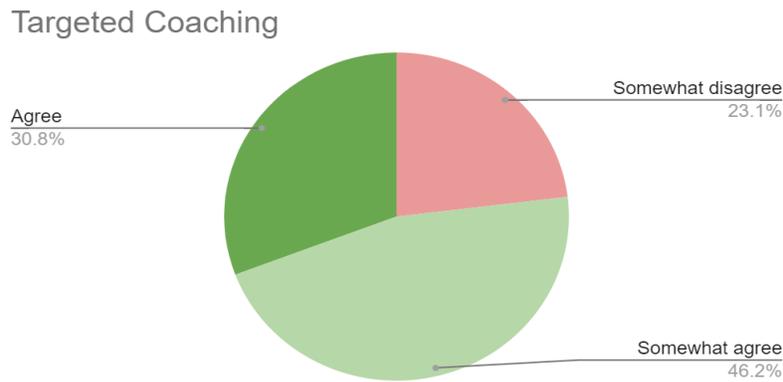
Experts predict that AI will impact Student Experience through Career Planning in higher education by 2030. We asked the participants to agree or disagree with this statement: *“[AI could] help to match students with alumni who match the student’s interests, profile and interests.”*



As shown in the figure above, the majority of the survey participants agreed or partially agreed that AI could help to match students with alumni who match the student’s interests, profile and interests by 2030. Approximately 15% of participants either slightly agreed or disagreed.

Category: Athletics
Subcategory: Targeted Coaching

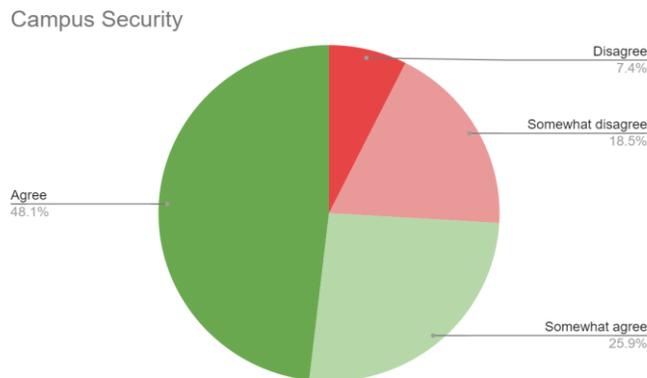
Experts predict that AI will impact Athletics through the implementation of Targeted Coaching in higher education by 2030. We asked the participants to agree or disagree with this statement: “[AI] could lead to personalized targeted coaching.” The distribution of the responses are shown below.



As shown in the figure above, the majority of the survey participants agreed or somewhat agreed that AI could lead to personalized targeted coaching by 2030. Although the majority of the responses were positive, about 23% of participants slightly disagreed. Of the participants who slightly disagreed, one participant noted: “Ai is currently focused on cognitive abilities. More research is needed to enable AI to help improve physical training”.

Category: Facilities
Subcategory: Campus Security

Experts predict that AI will impact Facilities through the implementation of Campus Security by 2030. We asked the participants to agree or disagree with this statement: “The use of AI systems will be deployed across non-academic elements as well, in terms of usage of facial recognition software for campus events, security, and building access.”



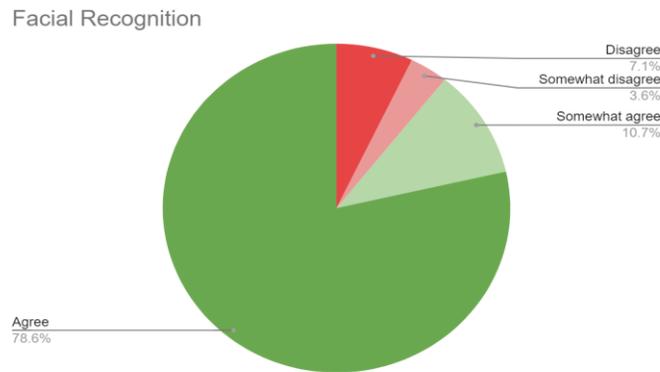
As shown in the figure above, the majority of the survey participants agree or somewhat agree that AI systems will be deployed for facial recognition software for campus events, security, and building access.

Although the majority of the responses were positive, about 26% of participants disagreed or slightly disagreed. Of the participants who disagreed, one noted privacy concerns surrounding AI in campus security: “I believe there will be backlash for using such privacy-invading technologies by universities, even if they are commonly used”. Another participant predicted that the AI capabilities will simply not be there by 2030: “I don’t see facial recognition being that good in 10 years to use it for something mission critical”.

Subcategory: Facial Recognition

Experts predict that AI will impact facilities through facial recognition in higher education by 2030. We asked the participants to agree or disagree with this statement:

“A potential detriment of [facial recognition] to watch is the unintended consequences of a surveillance state.”



As shown in the figure above, the majority of the survey participants agreed that a potential detriment of facial recognition is the unintended consequences of a surveillance state. Although the majority of the responses were positive, there were about 11% of participants who responded negatively to the statement. This indicated that most of the AI expert participants are aware of the risks involved with facial recognition.

Round 2: 2050

After obtaining the results from the 2050 section of Round 2, we assessed the responses and created a visual representation of the findings of each question to show how many participants agreed or disagreed with each statement. The findings can be seen below.

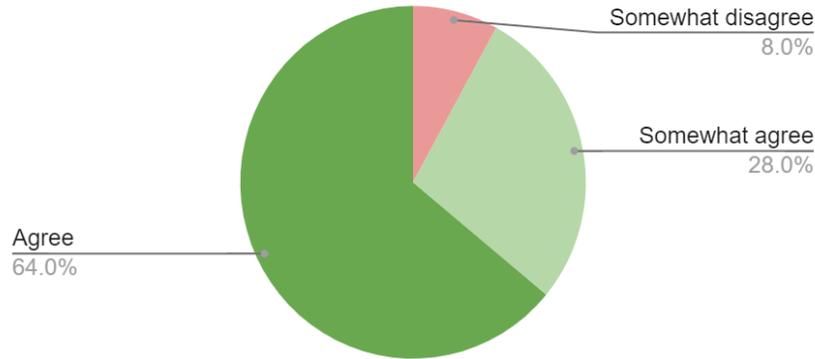
Category: Learning and Instruction

Subcategory: Online Courses

Experts predict that AI will impact Learning and Instruction in higher education by 2050. We first asked the participants to agree or disagree with this statement:

“Enhanced online learning with various telepresence devices that augment the learning experience [that may] run experiments remotely, and conduct more immersive virtual office hours.”

Online Courses



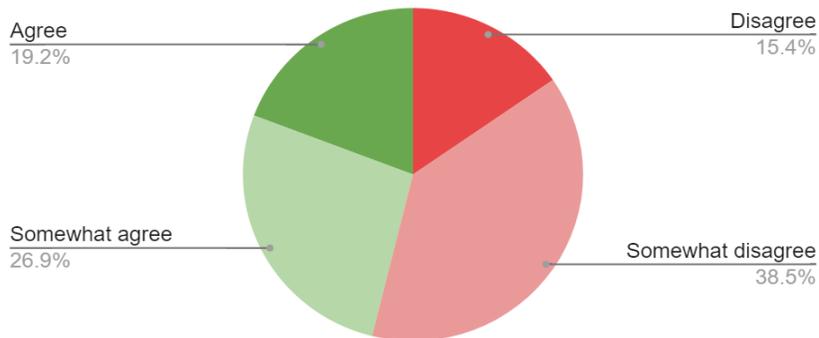
As shown in the figure above, the majority of the survey participants were on the positive side of the scale, either agreeing or somewhat agreeing with the statement presented to them. Although the majority of the responses were positive, there were about 8% of participants who responded negatively to the statement, however none fully disagreed with this statement. 64% of participants fully agreed with the statement presented, meaning they believe there could be an increase in existing trends in online courses by 2050.

Subcategory: Contextually Relevant Universities

We then asked the participants to agree or disagree with this statement:

“Will universities still be contextually relevant? With the growing capability of ubiquitous learning, universities will no longer be the gatekeeper of information - it will be readily available.”

Contextually Relevant Universities

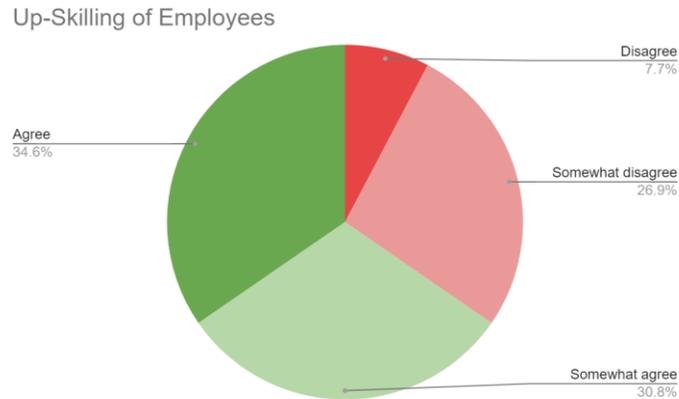


As you can see in the figure above, there was a lot of variance with all answer choices being represented. The responses are split up somewhat evenly across all four potential answer choices. However, the most popular answer was somewhat disagree with approximately 39% of survey participants somewhat disagreeing with the statement explaining how AI could replace contextually relevant universities by the year 2050.

Subcategory: Up-Skilling of Employees

We then asked the participants to agree or disagree with this statement:

“In the technology and other related industries we expect to see a dramatic increase in vertical up-skilling of employees as the demand for systems level thinking increases at a pace traditional higher education institutions cannot keep.”

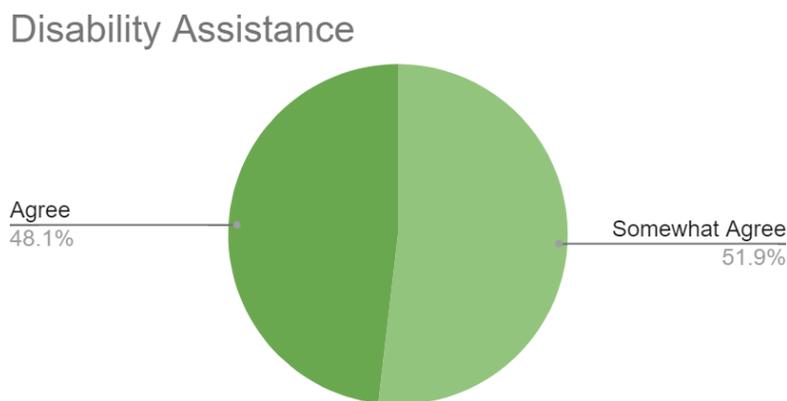


As shown in the figure above, there was some variance with all choices being represented. The majority of the survey participants agreed or partially agreed that AI could help with the up-skilling of employees by 2050. Approximately 35% of participants fully agreed, 31% somewhat agreed, 27% somewhat disagreed, and 8% fully disagreed.

Category: Student Experience
Subcategory: Disability Assistance

We then asked the participants to agree or disagree with this statement:

“Students with physical handicaps will have robotic helpers, students with limited vision will use all kinds of intelligent devices and robots to help them.”



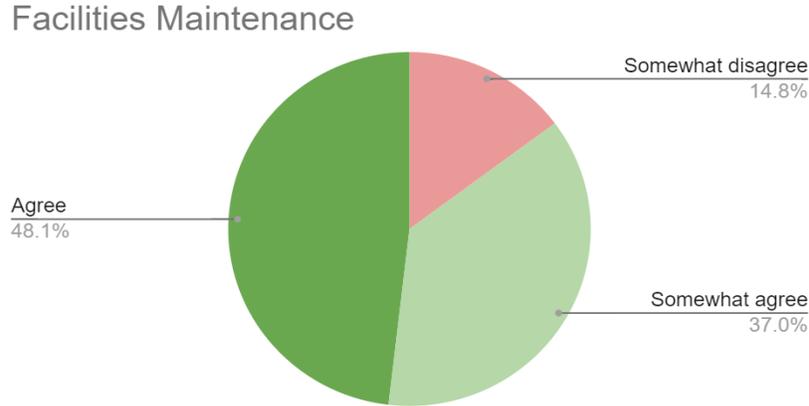
As shown in the figure above, all of the survey participants were on the positive side of the scale, either agreeing or somewhat agreeing with the statement presented to them. There were no negative responses to the statement presented. This means that they all either agree or somewhat agree that there could be an implementation of AI through disability assistance by the year 2050.

Category: Facilities

Subcategory: Maintenance and Repairs

We then asked the participants to agree or disagree with this statement:

“Robots will be deployed to perform maintenance and repairs, it will allow for virtual and interactive tours, help with emergency responses, etc.”



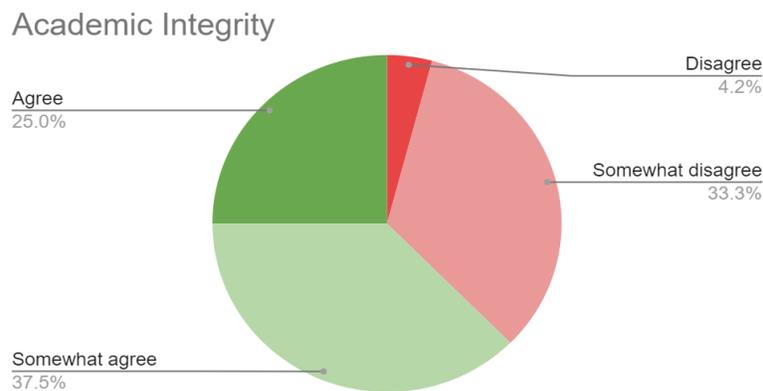
As shown in the figure above, the majority of the survey participants were on the positive side of the scale, either agreeing or somewhat agreeing with the statement presented to them. A total of 85% of participants were on the positive side of the scale, either agreeing or somewhat agreeing with the statement presented. Although the majority of the responses were positive, there were about 15% of participants who responded negatively to the statement, however none fully disagreed with this statement.

Category: Academic Integrity

Subcategory: Cheating

We then asked the participants to agree or disagree with this statement:

“Cheating will be in certain ways easier because intelligent programs will be able to gather information on a topic more easily.”



As shown in the figure above, there was some variance with all choices being represented. The majority of the survey participants agreed or partially agreed that with implementing AI the academic integrity of students decreases by 2050. Approximately 25% of participants fully agreed, 38% somewhat agreed, 33% somewhat disagreed, and 4% fully disagreed.

Appendix D: Quotes from Experts (Round 2: 2030)

As Round 2 of the Delphi Study was our most participated round, we would like to share some of the responses we obtained from the AI experts. The opinions were separated into two groups: “for” and “against” the implementation of AI in the listed categories of higher education. Below are the responses from the experts in regards to implementing AI in higher education by 2030.

2030 Responses (Learning and Instruction)		
Subcategory	“For” Arguments	“Against” Arguments
Intelligent Agents	One can easily imagine technical courses (such as math or introduction to programming) with video-recorded lectures and computer-driven display of content/questions.	I think there will still be a role for humans in tutoring. It's hard to predicate every possible scenario when tutoring a student.
Efficient Feedback	If you take a look at the computer science courses at WPI, a large percentage of the courses already implement this on coding assignments	Professors can be slow to give up their traditions. 10 years is not a long enough time frame for conversion to all automated grading, and I'm not sure that AI agents will be able to handle all the nuances of grading essays, for example, within 10 years
	Older Faculty may struggle with this, but newer faculty will likely see value and champion this as the value in quicker feedback loop helps learning	Depends on the field of study. Certainly true for something like a programming class, but very unlikely to be useful for literature.
	This also seems inevitable, given the current pandemic experience.	Online courses only go so far. They lack the ability to enable scholarly discourse about a topic.
	A question of whether it is worth spending a large amount of tuition to send your child to a	Not necessarily universities. New organizations such as edX or Coursera might displace some of what current

Online Courses	bottom-half university makes sense, when there are much cheaper online options.	universities do. A lot will depend on credentialing issues.
	Niche courses, only offered by smaller colleges could trend.	" Not necessarily to "around more powerful universities"
Personalized Learning Material	Personalized learning material is already available through many instructional products, produced in labs and through commercial companies.	This essentially describes a world of Montessori education. I think it would be wonderful and feasible, but impossible for regulatory and credentialing bodies to swallow in so few years.

2030 Responses (Enrollment)		
Subcategory	“For” Arguments	“Against” Arguments
Targeted Recruitment	"The recruitment process itself (Pre-application) could be impacted by AI. Universities could use tele-presence robots/online bots to answer questions, showcase facilities, highlight distinctive qualities, etc."	That sounds pretty awful to me. I think we already use 'algorithmic evaluation' but it is done by people, not computers. Most admissions offices would say that they go beyond grades and scores now. A machine may be more less prone to changing evaluations based on mood, but any AI system is also prone to biases.
	"Enrollment will start during high school where AI will track all student capabilities over time and match them to dynamic courses that start the college process while they are still in high school"	Will the information a student provides on an application allow this? How do you deal with less than honest applicants
Admissions	Enrollment will start during high school where AI will track all student capabilities over time and match them to dynamic courses that start the college process while they are still in high school	"There are concerns about bias, and there is a division at colleges that specializes in admissions. Those members get to exercise personal judgments in which candidates to accept or to exclude. I do not see them relinquishing power willingly. So yes, I think AI will be capable in 2030. I think

		I could do it by 2021 given access to some data and a couple of undergrads. But I don't think it will be widely used."
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2030 Responses (Student Experience)		
Subcategory	“For” Arguments	“Against” Arguments
Mental Health Evaluation	Interesting avenue [of] social/emotional support AI.	"[AI Mental Health Evaluations] are not realistic in the 2030 timeframe."
Counseling	"We already have really simple versions of such things"	"Nothing can beat personal interaction here."
	I'm sure these will be attempted.	"HIPPA/Privacy concerns may impede progress here."
Career Planning	AI could be used to help students identify potential careers that they may not have considered, again using student interests.	I'm not sure how much impact AI would have here. We could already do major and keyword matching. I'm not sure how much gain there is beyond that.
	Wouldn't be surprised if LinkedIn is already doing this behind the scenes with expanding one's network	I would hesitate using this as anything other than a possible avenue for learning and networking. As an information source this is helpful. As something that guarantees social interactions are set up, it is not.

2030 Responses (Athletics)		
Subcategory	“For” Arguments	“Against” Arguments
Personalized Physical Enhancement	At the olympic/professional level, I would expect to see it.	Harder to imagine how AI would get the raw data that would allow the personalized coaching. Cameras everywhere that could see the swing? Evaluate the kick?

2030 Responses (Facilities)		
Subcategory	“For” Arguments	“Against” Arguments
Campus Security	Agreed, but we have to be careful of using such technology.	I don't see facial recognition being that good in 10 years to use it for something mission critical. It has to be lax enough to accept someone growing a beard, wearing a ski cap or a scarf, but tight enough not to allow too many people who shouldn't be there. Keycards are a better solution.
	I think this will be deployed (more), although I am not personally a fan.	I believe there will be backlash for using such privacy-invading technologies by universities, even if they are commonly used elsewhere, such as at airports.
	We already see this in the UK and in China.	Reliable facial recognition (for example) is a very difficult problem and recent deployments have not gone well, both from a technical and social viewpoint. It's clear that AI technology will be deployed in non-academic areas but the social issues will probably determine how, where, and when.

Appendix E: Quotes from Experts (Round 2: 2050)

2050 Responses (Learning and Instruction)		
Subcategory	“For” Arguments	“Against” Arguments
Online Courses	I think we can do better than Zoom	I think the physical human perceptual system will continue to be more comfortable in actual physical environments for a long time. [...] I'm not sure we'll be able to build VR systems that can replace in-person meetings satisfactorily.
Contextually Relevant Universities	Information will be universally available (perhaps it already is).	Nothing will replace the name of certain institutions and the ability to live among scholarly fervent.
	The problem will be the reliability of the information. Look what's happening now on social media.	One of the key motivators to learning is the communal aspect. I've witnessed the power of the relationship between faculty and students, and between students, as an important aspect of learning. Content availability is no guarantee that it will be sought or effectively learned. Some organization of content, and accountability will still be important. Universities do that, and I believe, will continue to be important for those factors.
Upskilling of employees	I agree with the prediction of upskilling needed	This sounds like suggesting we can deepen skills training, albeit more cognitively aligned. We currently already expect/ask too much of this from assistants, and many comment that while the rate of clerical tasks has accelerated,

		<p>their quality has not improved on average. Humans are a physical system, and have limitations that are already pushed too hard to yield quality consistently in many, many contexts. I think it is more likely that the systems the average employee use will be better organized due to emerging social work customs and the diffusion of effective engineering practices, as information systems become a more 'historical' tool.</p>
	<p>Yes, learning will have to shift from more formal, college academic settings to the workplace.</p>	<p>I don't see a future in which you can learn all of your skills on the job. I believe higher education will be improved by AI, not replacing it.</p>

2050 Responses (Student Experience)		
Subcategory	“For” Arguments	“Against” Arguments
<p>Disability Assistance</p>	<p>I can imagine monitoring students for depression and dispensing a resident advisor to sound the student out. It could also suggest people it would make sense for you to meet. If predictive aspects get better, it might be able to help guide students with course/major selections. Interacting with a system about plausible job trends, and your likely success in various careers would be powerful</p>	<p>Helpful for many but not all, depending on circumstance.</p>

2050 Responses (Facilities)		
Subcategory	“For” Arguments	“Against” Arguments
<p>Campus Maintenance</p>	<p>There still needs to be some big break throughs in robotics, but I think this is feasible</p>	<p>The technology will be there, but I don't see society evolving that much in 30 years. Fundamentally we're social</p>

and Repair		animals, and most people would rather interact with a person than a robot
------------	--	---

2050 Responses (Academic Integrity)		
Subcategory	“For” Arguments	“Against” Arguments
Cheating	Cheating is always going to be possible.	Real learning is not about gathering information. It is about knowing how to use the information. By 2050 we should be better at devising assignments and assessments that evaluate the learning, rather than just the accumulation of facts. That will make cheating rather more difficult.

Appendix F: Round 3 Survey

Welcome!

Thank you so much for taking our survey! This study will help us fulfill our degree requirement at Worcester Polytechnic Institute (WPI). We will use this data to make recommendations to WPI based on the potential impacts of Artificial Intelligence on higher education.

This survey will take an **estimated 5-10 minutes**. The survey contains anonymous predictions about **Artificial Intelligence (AI) in higher education in 2030 and 2050** from previous survey participants.

We will ask you to **agree or disagree with these participants to the best of your ability**. There will be an **optional open response question** at the end of each section as an opportunity for you to express your original thoughts and insights. Thank you!

Informed Consent Agreement for Participation in a Research Study

Please read the attached informed consent and agree to the terms below to continue with this survey.

Informed consent

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

You will be presented with predictions about the following categories:

- Learning and Instruction
- Enrollment
- Student Experience
- Career Planning
- Athletics
- Facilities
- Data Analysis

Please Agree or Disagree with the predictions to the best of your ability. For example, a statement may predict that universities will be obsolete by 2050. Please agree if you think this is an accurate prediction or disagree if you think that it is not.

Please note the year referred to in each prediction. The years 2030 and 2050 are being examined in this survey.

You will have the option to write your thoughts in an [Optional notes] text box after each prediction.

You will have the opportunity to add your original predictions after each section, and again at the conclusion of the survey. You will have the opportunity to select the categories that you believe are the most important to the future of Artificial Intelligence in Higher Education.

Round 3 Survey Questions: Page 1

[Checkboxes]

Learning and Instruction

2030 Predictions:

Efficient Feedback

“Algorithms will dictate how grades are given out. While I don’t think learning criteria will change, I think the grading scales will become more dynamic to accommodate those with certain advantages.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Checkboxes]

“I suspect that grades are so important that assigning a fair value autonomously/automatically will not be fully trusted.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Checkboxes]

“[Automated grading and assessment to provide much faster feedback] will be beneficial for a programming class, but [automatic grading] is unlikely to be useful for literature.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]
Optional Notes

[Checkboxes]

Online Learning

“New Organizations such as edX or Coursera might displace some of what current universities do.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]
Optional Notes

[Checkboxes]

“Online courses only go so far. They lack the ability to enable scholarly discourse about a topic.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]
Optional Notes

[Open Response]

“Are there any other areas of **Learning and Instruction** that may be impacted by AI by 2030?
Please be as creative as possible with your response.

Round 3 Survey Questions: Page 2

[Checkboxes]

Learning and Instruction

2050 Predictions:

Relevance of Traditional Universities

“Will universities still be contextually relevant? With the growing capability of ubiquitous learning, universities will no longer be the gatekeeper of information - it will be readily available.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]
Optional Notes

[Checkboxes]

“Universities will be contextually relevant. Humans are social animals, and there is a benefit of face to face meetings. The past month has shown us that. So there is a place for central hubs for people to learn and push the frontiers of knowledge. Ergo, universities. Forget 2050, in 2020 universities are no longer the gatekeepers of information. Papers are available online, and in some fields private firms are conducting more advanced research than in academia.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]
Optional Notes

[Checkboxes]

“Nothing will replace the name of certain institutions and the ability to live among scholarly fervent.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]
Optional Notes

[Checkboxes]

“There will be a dramatic increase in vertical up-skilling of employees as the demand for systems level thinking increases at a pace traditional higher education institutions cannot keep.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Checkboxes]

Social Value of Higher Education

“One of the key motivators to learning is the communal aspect. I’ve witnessed the power of relationship between faculty and students, and between students, as an important aspect of learning.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Open Response]

Are there any other areas of **Learning and Instruction** that may be impacted by AI by 2050? Please be as creative as possible with your response.

[Checkboxes]

Academic Integrity

2050 Predictions:

Cheating

“Cheating will be easier in some ways because intelligent programs will be able to gather information on a topic more easily.”

- Disagree
- Somewhat Disagree

- Somewhat Agree
- Agree

[Open Response]
Optional Notes

[Checkboxes]

“Real learning is not about gathering information. It is about knowing how to use the information, By 2050, we should be better at devising assignments and assessments that evaluate the learning, rather than just the accumulation of facts. That will make cheating more difficult.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]
Optional Notes

[Open Response]

Are there any other areas of **Academic Integrity** that may be impacted by **AI by 2050**? Please be as creative as possible with your response.

[Checkboxes]

Student Experience
2030 Predictions:

Counseling

“Intelligent agents (on screen or on a cell phone or whatever devices we have in 10 years) could be available to provide counseling to students and faculty/staff for emotional challenges and cessation behaviors (smoking cessation, etc.)”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]
Optional Notes

<p>[Checkboxes]</p> <p>“[Intelligent agents providing counseling for emotional challenges] is happening already.”</p> <ul style="list-style-type: none"> <input type="checkbox"/> Disagree <input type="checkbox"/> Somewhat Disagree <input type="checkbox"/> Somewhat Agree <input type="checkbox"/> Agree
<p>[Open Response]</p> <p>Optional Notes</p>
<p>[Checkboxes]</p> <p>“Personal connection will continue to be an important part of the counseling experience.”</p> <ul style="list-style-type: none"> <input type="checkbox"/> Disagree <input type="checkbox"/> Somewhat Disagree <input type="checkbox"/> Somewhat Agree <input type="checkbox"/> Agree
<p>[Open Response]</p> <p>Optional Notes</p>
<p>[Checkboxes]</p> <p>Career Planning</p> <p>“AI could be used to help students identify potential careers that they may not have considered, again using student interests.”</p> <ul style="list-style-type: none"> <input type="checkbox"/> Disagree <input type="checkbox"/> Somewhat Disagree <input type="checkbox"/> Somewhat Agree <input type="checkbox"/> Agree
<p>[Open Response]</p> <p>Optional Notes</p>
<p>[Open Response]</p> <p>Are there any other areas of Student Experience that may be impacted by AI by 2030? Please be as creative as possible with your response.</p>

<p>[Checkboxes]</p>

Student Experience

2050 Predictions:

Disability Assistance

“Students with physical handicaps will have robotic helpers, students with limited vision will use all kinds of intelligent devices and robots to help them.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Open Response]

Are there any other areas of **Student Experience** that may be impacted by AI by **2050**? Please be as creative as possible with your response.

[Checkboxes]

Athletics

2030 Predictions:

Personalized Physical Enhancement

“AI [could] get the raw data that would allow the personalized coaching. [This could involve] Cameras everywhere that could see the swing? Evaluate the kick?”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Open Response]

Are there any other areas of **Athletics** that may be impacted by AI by **2030**? Please be as creative as possible with your response.

[Checkboxes]

Facilities

2030 Predictions:

Campus Security

“Facial recognition for campus events, security, and building access are all feasible predictions for 2030.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Checkboxes]

“Reliable facial recognition (for example) is a very difficult problem and recent deployments have not gone well, both from a technical and social viewpoint.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Checkboxes]

“Many issues of privacy and transparency must be reached before this is allowed.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]

Optional Notes

[Checkboxes]

“A potential detriment of [facial recognition] to watch is the unintended consequence of a surveillance state.”

- Disagree
- Somewhat Disagree
- Somewhat Agree
- Agree

[Open Response]
Optional Notes

[Open Response]
Are there any other areas of **Facilities** that may be impacted by AI by **2030**? Please be as creative as possible with your response.

[Rank Order]

Open Response

2030 Predictions

By 2030, which of the following university areas will change the most with AI technology?

For example, a top rank (1-3) indicates you believe AI will have a large impact in that area and a low rank (5-7) indicates you believe AI will have a lesser impact in that area.

Note: Click and drag the categories to rank them

1. Learning and Instruction
2. Enrollment
3. Student Experience
4. Career Planning
5. Athletics
6. Facilities
7. Data Analysis

[Open Response]
Optional Notes

[Rank Order]

Open Response

2050 Predictions

By 2050, which of the following university areas will change the most with AI technology?

For example, a top rank (1-3) indicates you believe AI will have a large impact in that area and a low rank (5-7) indicates you believe AI will have a lesser impact in that area.

Note: Click and drag the categories to rank them

8. Learning and Instruction

- 9. Enrollment
- 10. Student Experience
- 11. Career Planning
- 12. Athletics
- 13. Facilities
- 14. Data Analysis

[Open Response
Optional Notes

[Open Response]

Did anything in this survey surprise you or change your mind? Do you have any new insights after reading these responses? Please be as specific as possible.

Appendix G: Round 3 Detailed Report

2030

After obtaining the results from the 2030 Section of Round 3, created a visual representation of the findings of each subsection to show how many participants agreed or disagreed with each statement. The findings can be seen below:

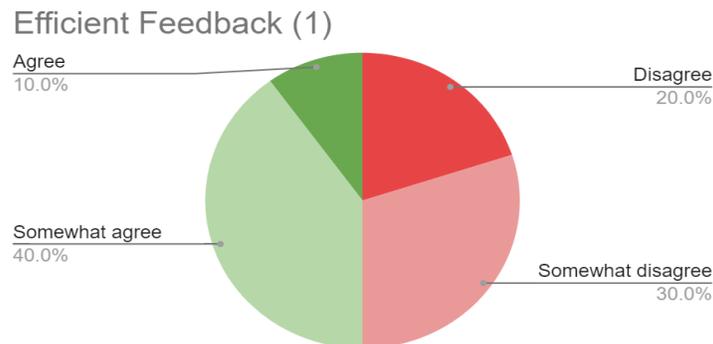
Category: Learning and Instruction

Subcategory: Efficient Feedback

Experts predict that AI will impact Learning and Instruction in higher education by 2030. We first asked the participants to agree or disagree with this statement:

“Algorithms will dictate how grades are given out. While I don't think learning criteria will change, I think the grading scales will become more dynamic to accommodate those with certain advantages”

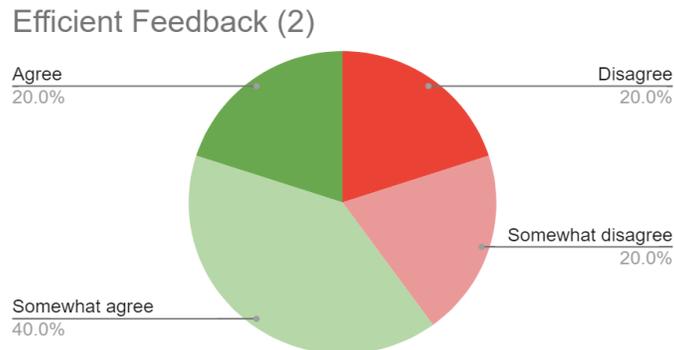
The distribution of responses are shown below.



As shown above, participants were split on whether algorithms will determine how grades are given out in 2050 with 50% of participants either agreeing or somewhat agreeing and 50% of participants disagreeing or somewhat disagreeing.

We then asked the participants to agree or disagree with this statement:

“I suspect that grades are so important that assigning a fair value autonomously/automatically will not be fully trusted.” The distribution of responses are shown below.

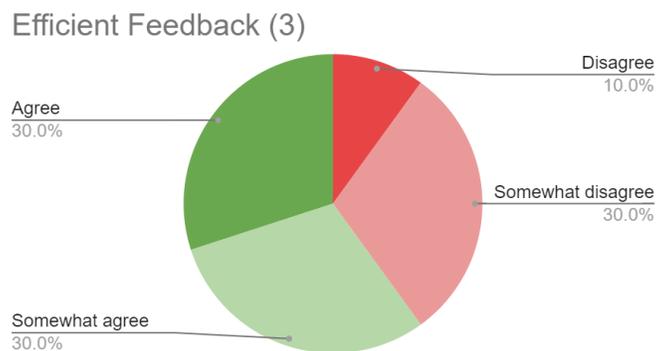


As seen above, participants were almost evenly split on whether grading would be entrusted to AI by 2030 with 60% of participants agreeing or somewhat agreeing and 40% of participants disagreeing or somewhat disagreeing.

We then asked the participants to agree or disagree with this statement:

“[Automated grading and assessment to provide much faster feedback] will be beneficial for a programming class, but very [automatic grading] is unlikely to be useful for literature.”

The distribution of responses are shown below.



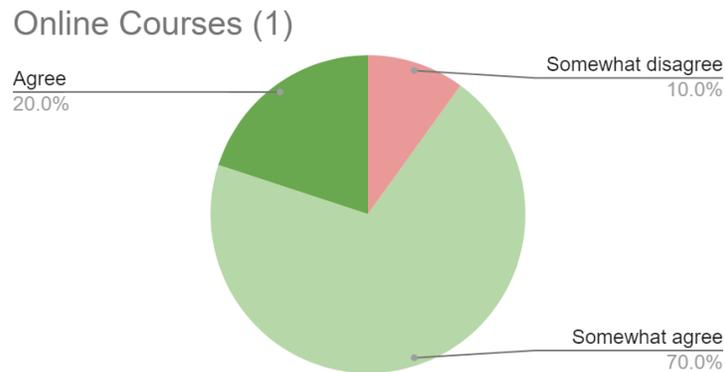
As seen above, participants were almost evenly split on if AI grading would be used in classes involving things such as coding, but not in classes involving literature by 2030 with 60% of participants agreeing or somewhat agreeing and 40% of participants disagreeing or somewhat disagreeing.

Subcategory: Online Courses

We then asked the participants to agree or disagree with this statement:

“New organizations such as edX or Coursera might displace some of what current universities do.”

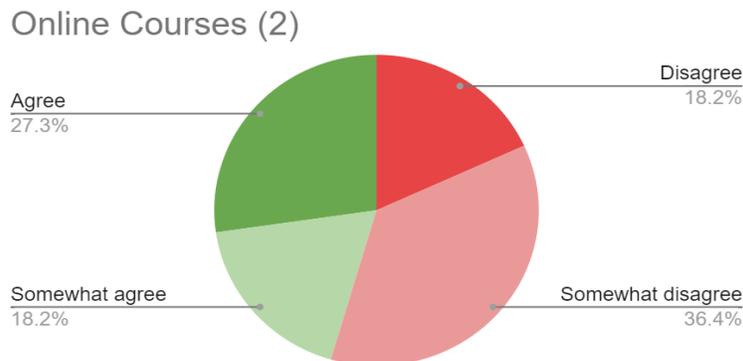
The distribution of responses are shown below.



As shown above, almost all of the participants agreed or somewhat agreed that certain new institutions will replace some of what colleges do by 2030 with 90% of participants agreeing or somewhat agreeing.

We then asked the participants to agree or disagree with this statement:

“Online courses only go so far. They lack the ability to enable scholarly discourse about a topic.”



The distribution of responses are shown below.

As shown above, participants were split on if online classes lacked the ability to enable scholarly discourse about a topic with about 45% of participants agreeing or somewhat agreeing and 55% disagreeing or somewhat disagreeing.

Category: Student Experience

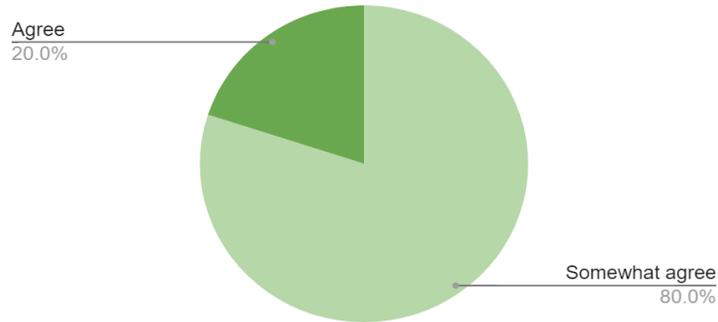
Subcategory: Counseling

Experts predict that AI will impact Student Experience in higher education by 2030. We first asked the participants to agree or disagree with this statement:

“Intelligent agents (on screen or on a cell phone or whatever devices we have in 10 years) could be available to provide counseling to students and faculty/staff for emotional challenges and cessation behaviors (smoking cessation, etc.)”

The distribution of responses are shown below.

Counseling (1)



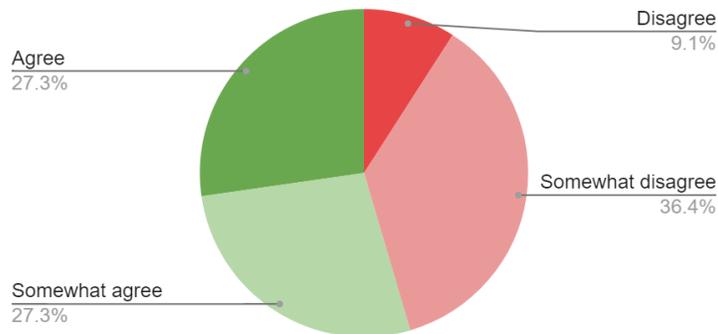
As shown above, 100% of participants felt that intelligent agents would be able to provide counseling for emotional challenges and troubling behaviors.

We then asked the participants to agree or disagree with this statement:

“[Intelligent agents providing counseling for emotional challenges] is happening already.”

The distribution of responses are shown below.

Counseling (2)



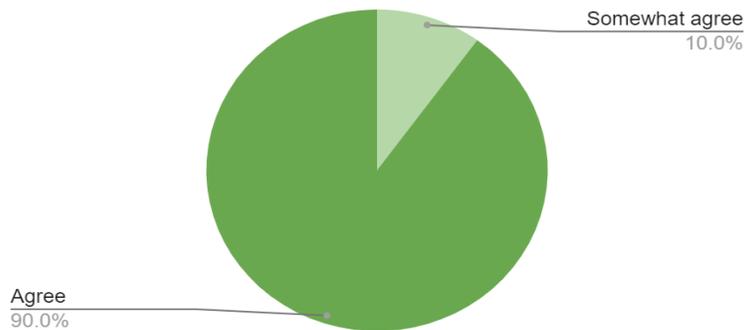
As shown above, participants were split on if the use of intelligent agents for emotional counseling is already happening with about 55% of participants agreeing or somewhat agreeing and 45% of participants disagreeing or somewhat disagreeing.

We then asked the participants to agree or disagree with this statement:

“Personal connection will continue to be an important part of the counseling experience.”

The distribution of responses are shown below.

Counseling (3)



As shown above, 100% of the participants felt that despite the use of intelligent agents, personal connection would remain a part of the counseling process.

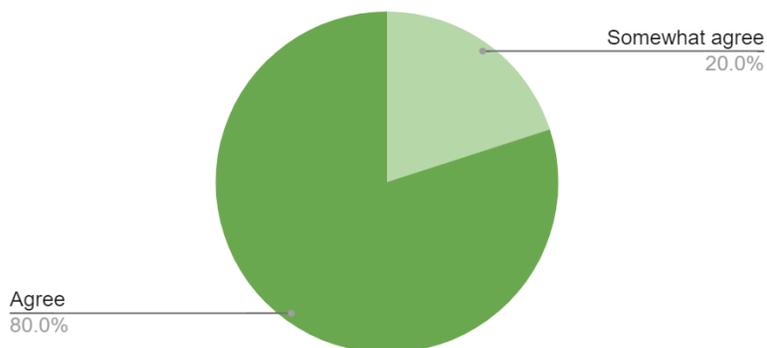
Subcategory: Career Planning

We then asked the participants to agree or disagree with this statement:

“AI could be used to help students identify potential careers that they may not have considered, again using student interests.”

The distribution of responses are shown below.

Career Planning



As shown above, 100% of participants felt that AI could be used to help students identify career paths that they may not have thought of or intended to pursue.

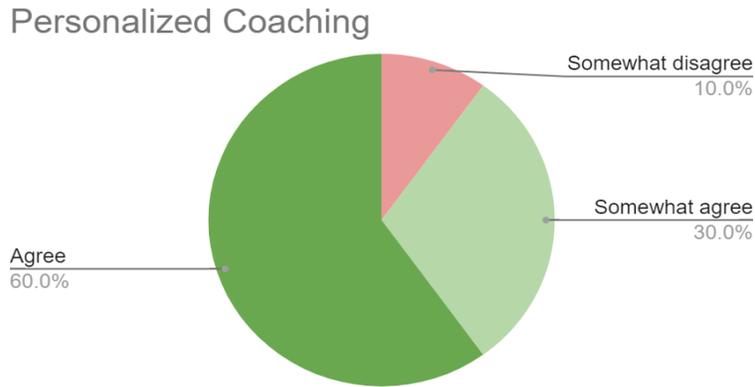
Category: Athletics

Subcategory: Personalized Coaching

Experts predict that AI will impact Athletics in higher education by 2030. We first asked the participants to agree or disagree with this statement:

“AI [could] get the raw data that would allow the personalized coaching. [This could involve] Cameras everywhere that could see the swing? Evaluate the kick?”

The distribution of responses are shown below.



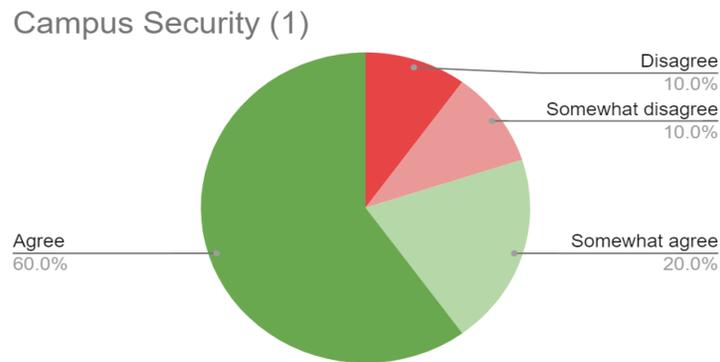
As shown above, a large majority of participants felt that the necessary data could be collected for AI to be used for personalized coaching with 90% of participants either agreeing or somewhat agreeing.

Category: Facilities
Subcategory: Campus Security

Experts predict that AI will impact Facilities in higher education by 2030. We first asked the participants to agree or disagree with this statement:

“Facial recognition for campus events, security, and building access are all feasible predictions for 2030.”

The distribution of responses are shown below.



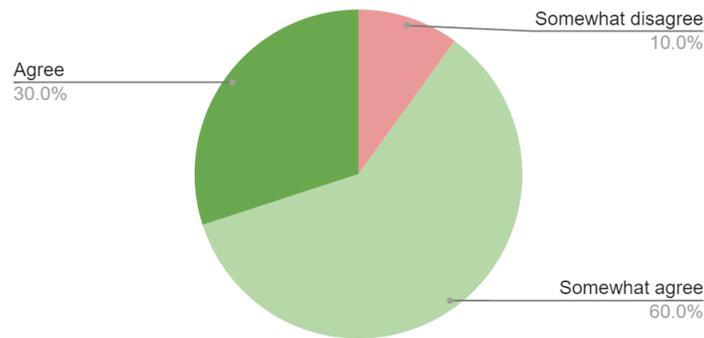
As shown above the majority of participants felt that AI could be used for facial recognition software for things like event security and building access by 2030 with 80% of participants agreeing or somewhat agreeing.

We then asked the participants to agree or disagree with this statement:

“Reliable facial recognition (for example) is a very difficult problem and recent deployments have not gone well, both from a technical and social viewpoint.”

The distribution of responses are shown below.

Campus Security (2)



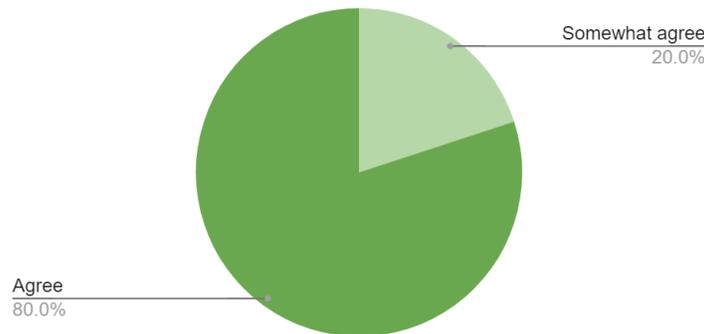
As shown above, a large majority of participants felt that reliable facial recognition is a difficult process that has not gone well recently with 90% of participants agreeing or somewhat agreeing. Many people have changed their view after reading this question.

We then asked the participants to agree or disagree with this statement:

“Many issues of privacy and transparency must be reached before this [facial recognition] is allowed.”

The distribution of responses are shown below.

Campus Security (3)



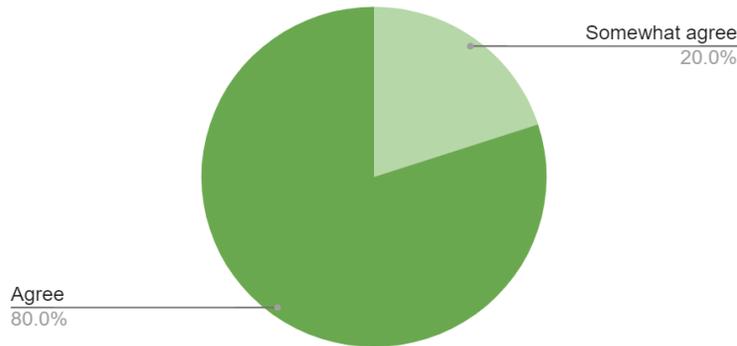
As shown above 100% of participants agreed that many privacy concerns must be addressed before facial recognition can be used for security or other purposes.

We then asked the participants to agree or disagree with this statement:

“A potential detriment of [facial recognition] to watch is the unintended consequences of a surveillance state”

The distribution of responses are shown below.

Campus Security (4)



As shown above, 100% of participants agreed that the use of AI for facial recognition could lead to the unwanted consequence of a surveillance state. Agreement with this and the last statement indicates that experts may feel facial recognition could but shouldn't be used, or they realize there are problems with facial recognition despite its advantages.

2050

After obtaining the results from the 2050 Section of Round 3, created a visual representation of the findings of each subsection to show how many participants agreed or disagreed with each statement. The findings can be seen below:

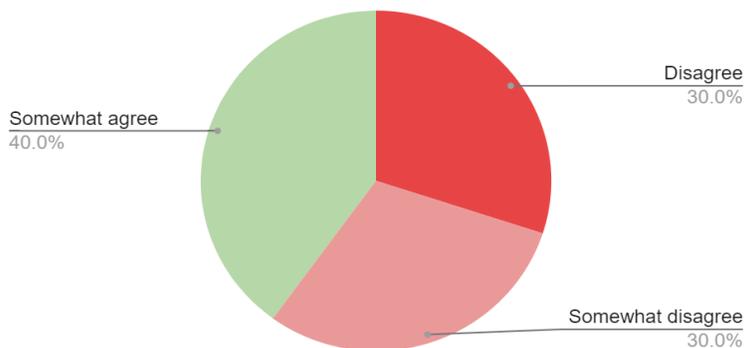
Category: Learning and Instruction Subcategory: Relevance of Traditional Universities

Experts predict that AI will impact Learning and Instruction in higher education by 2050. We first asked the participants to agree or disagree with this statement:

“Will universities still be contextually relevant? With the growing capability of ubiquitous learning, universities will no longer be the gatekeeper of information - it will be readily available.”

The distribution of responses are shown below.

Relevance of Universities (1)



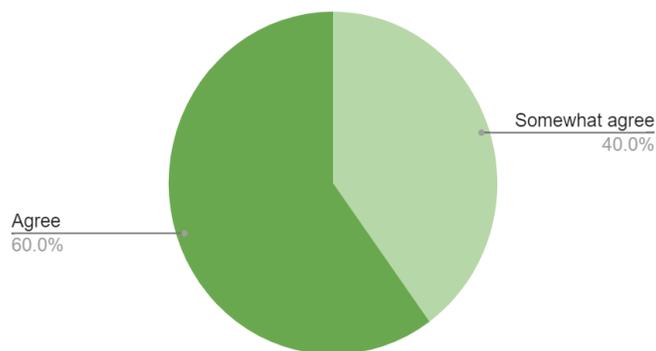
As shown above, participants were split on whether or not universities would still be relevant or the gatekeepers of information by 2050 with 60% disagreeing or somewhat disagreeing and 40% somewhat agreeing. This may indicate that some participants disagree about universities losing relevance but agreeing with the statement that they will not be the gatekeepers of information.

We then asked the participants to agree or disagree with this statement:

“Universities will be contextually relevant. Humans are social animals, and there is a benefit of face to face meetings. The past month has shown us that. So there is a place for central hubs for people to learn and push the frontiers of knowledge. Ergo, universities. Forget 2050, in 2020 universities are no longer the gatekeepers of information. Papers are available online, and in some fields private firms are conducting more advanced research than in academia.”

The distribution of responses are shown below.

Relevance of Universities (2)



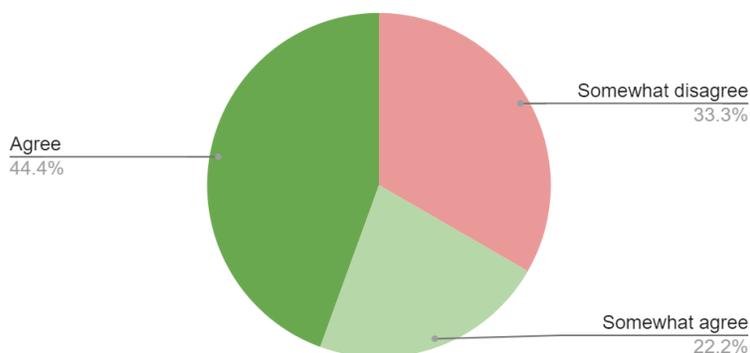
As shown above, 100% of participants agreed that while universities may no longer be the gatekeeper of information by 2050, they would still be relevant due to the social nature of humans.

We then asked the participants to agree or disagree with this statement:

“Nothing will replace the name of certain institutions and the ability to live among scholarly fervent.”

The distribution of responses are shown below.

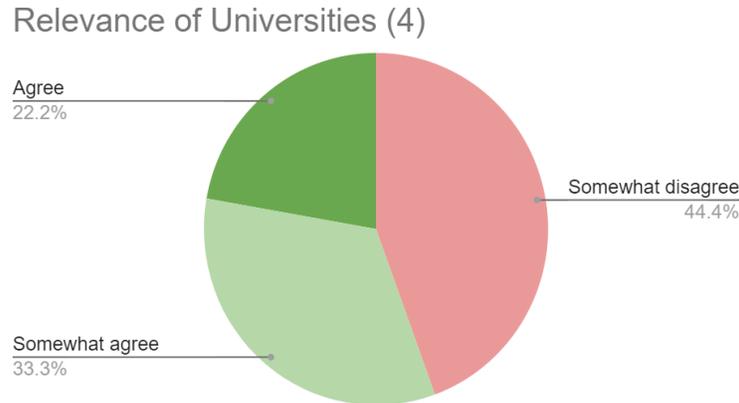
Relevance of Universities (3)



As shown above, the majority of participants felt that nothing could replace the names and scholarly feel of some universities with 67% agreeing or somewhat agreeing and 33% somewhat disagreeing.

Subcategory: Upskilling of Employees

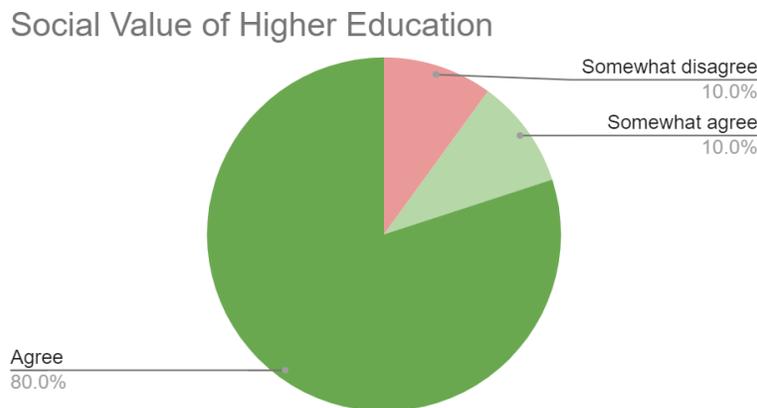
We then asked the participants to agree or disagree with this statement:
 “There will be a dramatic increase in vertical up-skilling of employees as the demand for systems level thinking increases at a pace traditional higher education institutions cannot keep.”
 The distribution of responses are shown below.



As shown above, the majority of participants felt that there would be an increase in vertical upskilling by 2050 with 67% agreeing or somewhat agreeing and 33% somewhat disagreeing.

Subcategory: Social Value of Higher Education

We then asked the participants to agree or disagree with this statement:
 “One of the key motivators to learning is the communal aspect. I’ve witnessed the power of the relationship between faculty and students, and between students, as an important aspect of learning.”
 The distribution of responses are shown below.



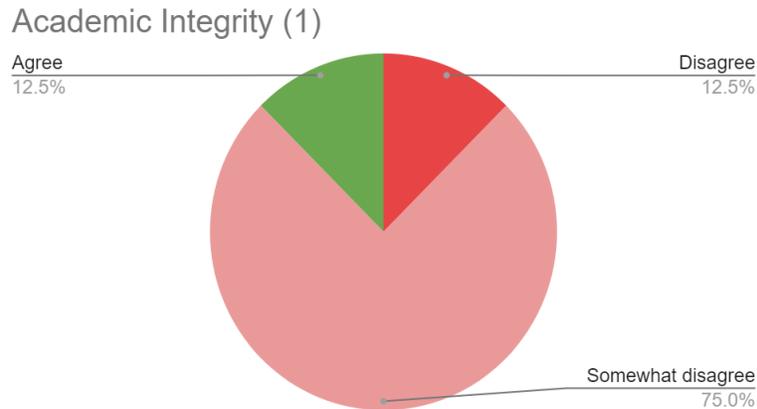
As shown above the majority of participants agree that one of the key motivators for learning is the communal aspect including relationships formed between students and teachers with 90% agreeing or somewhat agreeing.

Subcategory: Academic Integrity

We then asked the participants to agree or disagree with this statement:

“Cheating will be easier in some ways because intelligent programs will be able to gather information on a topic more easily”

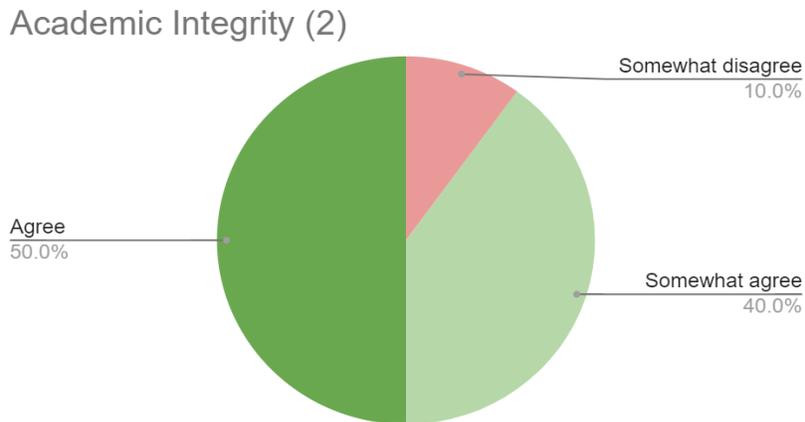
The distribution of responses are shown below.



As shown above the majority of participants felt that cheating would not be easier by 2050 because of the aid of AI with 87% of participants disagreeing or somewhat disagreeing.

We then asked the participants to agree or disagree with this statement:
“Real learning is not about gathering information. It is about knowing how to use the information. By 2050 we should be better at devising assignments and assessments that evaluate the learning, rather than just the accumulation of facts. That will make cheating more difficult.”

The distribution of responses are shown below.



As shown above the majority of participants felt that cheating would not be easier in 2050 because better ways of testing knowledge will be developed by 2050. 50% of participants agreed and 40% of participants somewhat agreed with this statement.

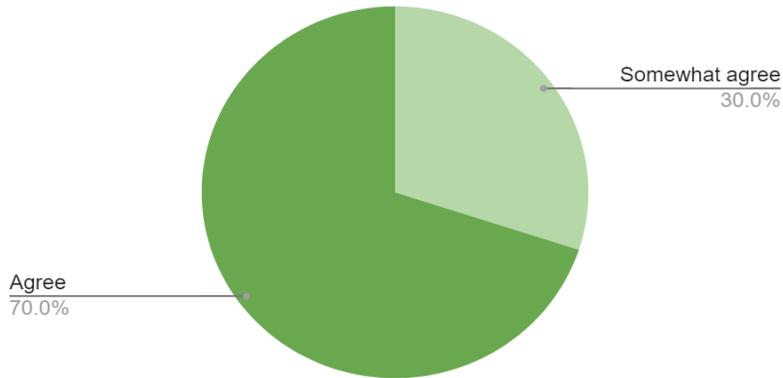
Category: Student Experience
Subcategory: Disability Assistance

Experts predict that AI will impact Student Experience in higher education by 2050. We first asked the participants to agree or disagree with this statement:

“Students with physical handicaps will have robotic helpers, students with limited vision will use all kinds of intelligent devices and robots to help them”

The distribution of responses are shown below.

Disability Assistance



As shown above 100% of participants felt that by 2050 intelligent agents and robots will be able to assist students with physical disabilities.

This chart depicts the responses given by our participants in the “optional notes” open responses contained in the round 3 survey

	Explanations in support	Explanations against
Category: Learning and Instruction	---	---
Subcategory: Relevance of universities	---	---
Will universities still be contextually relevant? With the growing capability of ubiquitous learning, universities will no longer be the gatekeeper of information - it will be readily available.		As before, universities will still be relevant but will not be gatekeepers.
		Personal interaction in the classroom is a very strong mechanism for keeping students interested.

<p>Universities will be contextually relevant. Humans are social animals, and there is a benefit of face to face meetings. The past month has shown us that. So there is a place for central hubs for people to learn and push the frontiers of knowledge. Ergo, universities. Forget 2050, in 2020 universities are no longer the gatekeepers of information. Papers are available online, and in some fields private firms are conducting more advanced research than in academia.</p>	<p>Couldn't have said it better myself :-)</p>	
	<p>Much of what universities do is push the frontiers of knowledge in the classroom and laboratories. This should not go away.</p>	
<p>Nothing will replace the name of certain institutions and the ability to live among scholarly fervent.</p>		<p>With a caveat that some people might choose Google as an institution over many universities.</p>
<p>There will be a dramatic increase in vertical up-skilling of employees as the demand for systems level thinking increases at a pace traditional higher education institutions cannot keep.</p>		<p>Speed will not replace depth.</p>
<p>Sub Category: Academic Integrity</p>	<p>---</p>	<p>---</p>

<p>Cheating will be easier in some ways because intelligent programs will be able to gather information on a topic more easily</p>		<p>I'm still not sure what constitutes cheating in such a world. I've heard rumors that in 2020 some students no longer proofread their own papers to find misspelled words and instead use software to do it! Some students even use the software to correct the spelling.</p>
		<p>One of the major objectives is to hone critical thinking. You can't look this up.</p>
<p>Real learning is not about gathering information. It is about knowing how to use the information. By 2050 we should be better at devising assignments and assessments that evaluate the learning, rather than just the accumulation of facts. That will make cheating more difficult.</p>		
<p>Sub Category: Social Value of Higher Education</p>	<p>---</p>	<p>---</p>
<p>Category: Student Experience</p>	<p>---</p>	<p>---</p>
<p>Sub Category: Disability Assistance</p>	<p>This is already happening in certain schools and with certain students.</p>	
<p>Students with physical handicaps will have robotic helpers, students with limited vision will use all kinds of intelligent devices and robots to help them</p>		<p>In addition to all the new gadgets, one still has to have the financial resources for them.</p>

		Again, it depends upon the development of technology that serves but doesn't get in the way
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Appendix H: Feedback Survey

Welcome!

Welcome to our survey. We would like to thank you for taking the time to participate in our survey. This study will help us fulfill our degree requirement at Worcester Polytechnic Institute.

Study Purpose: We would like to know how experts in the field of Artificial Intelligence (AI) believe that AI will influence higher education by the years 2030 and 2050. Using the opinions of worldwide AI experts, we will provide Worcester Polytechnic Institute with recommendations on how to successfully implement AI to **increase their competitive standing** by 2030 and by 2050.

We are asking you to use your expertise to give feedback regarding the use of AI at WPI:

- for the year 2030

- for the year 2050

This survey will take approximately 5-10 minutes. The survey contains anonymous predictions about AI in higher education.

Informed Consent Agreement for Participation in a Research Study

Please read the attached informed consent and agree to the terms below to continue with this survey.

Informed Consent

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

Survey Instructions

You will be presented with predictions about the following categories

- Learning and Instruction
- Enrollment
- Student Experience
- Career Planning
- Athletics
- Facilities
- Other

You will be asked to create two resource allocation plans, one for 2030 and one for 2050. We will provide you with a brief report of the findings from our Delphi Study. Please use this report to guide your decision on where you will allocate resources.

Please note the year referred to in each question. The years 2030 and 2050 are being examined in this survey.

You will have the opportunity to add your original predictions after each section, and again at the conclusion of the survey.

Delphi Study Report Attachment

Feedback Survey Questions: Page 1

Resource Allocation 2030

Using the expert AI predictions, please allocate points based on how you would distribute resources to create the best AI plan for 2030. **You have exactly 100 points to distribute, you may use no more and no less than 100 points.** Remember to give the most amount of points to the areas that you deem most important for AI to become involved in. Resource points are representing that importance and emphasis that you would hypothetically put on this area.

The areas you can allocate resources towards are

- Learning and Instruction
- Student Experience
- Enrollment
- Career Planning
- Athletics
- Facilities
- OTHER

These areas have been chosen after we carefully thematically coded the expert predictions from our Delphi Study. These are the areas that Artificial Intelligence experts from all over the world deem most important in the future of higher education AI.

While allocating resources, please keep in mind the goal of our study is to **increase WPI's competitive standing in 2030** through the successful implementation of AI.

[Constant Sum]

Resource Allocation 2030

[Open Response]

Optional Notes

Feedback Survey Questions: Page 2

Resource Allocation 2050

Using the expert AI predictions, please allocate points based on how you would distribute resources to create the best AI plan for 2050. **You have exactly 100 points to distribute, you may use no more and no less than 100 points.** Remember to give the most amount of points to the areas that you deem most important for AI to become involved in. Resource points are representing that importance and emphasis that you would hypothetically put on this area.

The areas you can allocate resources towards are

- Learning and Instruction
- Student Experience
- Enrollment

- Career Planning
- Athletics
- Facilities
- OTHER

These areas have been chosen after we carefully thematically coded the expert predictions from our Delphi Study. These are the areas that Artificial Intelligence experts from all over the world deem most important in the future of higher education AI.

While allocating resources, please keep in mind the goal of our study is to **increase WPI's competitive standing in 2050** through the successful implementation of AI.

[Constant Sum]
Resource Allocation 2050

[Open Response]
Optional Notes

Feedback Survey Questions: Page 3

[Open Response]
Did anything in this survey surprise you or change your mind? Do you have any new insights after reading the Delphi Study report?

Appendix I: Ethics Interview Transcript

The following is an abridged version of our ethical considerations interview with Jennifer deWinter of Worcester Polytechnic Institute. The transcript has been edited for conciseness and clarity. Text in italics indicates a member of our team speaking. All other text is Professor deWinter speaking.

Thank you so much for meeting with us. We wanted to give you some background about our project. We asked AI experts to look at what AI will look like in 2050, and then what AI will look like in the near future in 2030. This is an exploratory study so we wanted to get that breadth of here's all the areas that it could possibly impact, but it would help we could kind of ask you about more specific scenarios like: Do you have any concerns with that statement of having AI programs select students to come to WPI?

AI is almost always racist and sexist, right, because it depends on the body of data that you're drawing from to train your neural network. Humans are racist and sexist, and oftentimes AI will

in fact exacerbate that. And so, if I think about who does very well at WPI AI and what type of students that we tend to attract and what type of student we struggled to retain the AI will identify white middle class men.

Okay. That's great. Thank you.

We also had a response that kind of talked about how by 2050 the capabilities will be there to help with Disability Assistance this, we see it as like a really great tool. Do you see any concerns with having an intelligent machine help in this area?

That works right how are we then defining disability and then how are we defining normal AI is gonna have a lot of biases built into the system.

Again, AI is only ever reflective of the current practices. AI is a misnomer. We miss-named it by calling it intelligence; it's not intelligent. Right, so there's no, there's no case of suddenly veering very left and then figuring out a different innovative way to do something. And so, If I think about the ways in which people are imagining machine learning and AI to address challenges with disability, whether that's physical disability or neuro diversity, or a slew of other ones right, it's always predicated on the idea of normal, rather than asking the system to become more accommodating to the breadth and variety of human bodies.

We also did have a different type of response: it predicted that by 2050 that universities will not be relevant anymore, because they won't be the holder of information anymore. Do you have any thoughts on that?

And I'm not joking about the fact that people have been saying that for 2000 years; universities are always going to be relevant, education is always going to be relevant. If we think about again what AI will teach or how AI teaches. It teaches a very narrow set of a standard work similar to that seen in Lean Process Management. So we're no longer training the best and the brightest under AI education, we're training everyone to a standard. And that means that innovative new ways of thinking, innovative new approaches to problems any form of innovation functionally disappears under AI.

Do you see any areas in particular that you would picture AI existing in by 2030 or by 2050 that it would fit well and that it would help out in a big way?

It's in early detection of student error in process. So saying okay this student is trying to master these skills that they need to learn in order to move on, such as in calculus. I'm going to catch them when they're doing a couple of problems, and then I'm either going to alert a professor or or I'm going to interject something. We've also seen AI use pretty successfully to grade written papers with surprising normative accuracy when compared to human graders, right, so again not for innovative style and not for innovative new content but for kind of hitting the high points of this is lucid, it has an argument.

So I guess one of the categories that we got a lot of responses about was in personalized learning instruction, similar to your example of calculus and adjusting students, if they'd made the same mistake a few times or something. But would you say there's also the problem there like you talked about with like the standard performance of teaching everyone to the average level?

When the answers are confined and knowable, that's when it works well. And almost every discipline has that you need to learn basic knowledge before moving on to the more difficult stuff. It works fine there but even then I would argue it doesn't always work fine. You all have now moved online for your education. And for AI to function as a personalized learning environment, all of your learning is now online. And it's highly individualized and highly isolated. You've only been doing it for seven weeks, how does it feel?

It definitely wears on you.

Right, so imagine if all of education switched to that.

Right, so there's this assumption that my computer and I are going to have a beautiful relationship, but we already know that that's not going to happen and in fact like articles or psychology articles that are coming out about zoom fatigue. People are talking about, Oh, people are becoming really depressed over the only learning experiences being via the computer, even if it is with the live face to face learning.

Learning is ontological, as well as epistemological right so epistemology is knowing the world through thinking about it right it's a logical system ontology is knowing the world through your body when your body is in that place, and that you get excited and that you feel other people's excitement in the physicality of my body in that space matters to how I process information. If we move to AI it's the assumption that all humans are logical human beings and we're not we're emotional body, human beings.

So going along with that, how do you feel about AI, taking a larger role in counseling and mental health evaluations?

I guess I tend never to feel good about the quantified self, right, and so one of the things you're talking about is that the research calls quantified selves. I understand that the allure of it is that the more data that we can upload the more control we have over our own selves and the ideas that we can then rationally, attend to ourselves. But also I always have low level concerns about the ethics of data and surveillance culture right so who has access to that data, when is that data going to be used. What happens when that data is hacked. How is it going to be used in the privatized healthcare system that the US has, in terms of denying coverage.

I guess just kind of guessing here but like for the AI to work you'd be like, Oh, you know, like so many people are sad because of this reason so you're sad that like, this is a likely reason behind it. And I have to imagine it kind of takes away from the person feeling like they went through the effort to like get the help. And now it's not even personalized for them.

Someone brought up using AI with facial recognition for security, and one of the main things that we could see as people who don't know a lot about the ethics of AI that was a red flag.

Yeah. That's terrible.

Right, so surveillance state surveillance states are always there to surveil the body and control it. It's no accident that 1984 gets written. Animal Farm right like these, these are about the horrors of the surveillance state.

And so if you think about when there's another thing to think about when you think about things like facial surveillance right even like phone surveillance, whatever, we'll go to facial. Once you start going to biometric data.

Then, if your biometric data is ever hacked, you can't change your face.

Well thank you so much for all of this insight. This is so awesome and this is going to be great for our project so thank you so much for that. I'm wondering if you would like to remain anonymous. We had all of our survey participants in the Delphi Study because that's traditionally anonymous stay that way. Would you like to be in our acknowledgments or would you like to remain anonymous?

I'm fine not being anonymous. I don't mind having my words associated with me, so whatever is useful to you.

Thank you. Thank you, a ton for doing this. I learned a lot from this that I definitely was not expecting to take away from this.

Yay. Okay, I'll talk to you guys soon then. I look forward to reading through your paper.

Thank you so much.

Appendix J: Ethics Expert Email

The following is an example of a detailed email we received from an ethicist. The transcript has been edited for clarity.

I imagine that introducing AI into a university context would require a concerted effort to collect, classify, and store data. Students might be subject to constant surveillance, including their non-academic time. This could create many issues related to privacy as well as psychological stress. Students with non-normative (gender, sexual, religious, political, etc.) identities could be extremely vulnerable without a strict policy on non-discrimination or without an administration that would honor such a commitment.

I imagine if AI is going to use data to evaluate and assess student performance, students might want to have the right to challenge AI's decision or recommendation on their performance. Students currently have similar rights to challenge their grades. This might mean a black box AI system would not help resolve such a complex situation. Universities might need to invest in

explainable AI systems for this reason. There is also the question of data ownership. Who owns the data? If universities do, can it be commodified or not? If it is, can it be sold to a third party? This could be justified as a way of improving AI systems by increasing training data — not with a profit motive. Currently the Family Educational Rights and Privacy Act (FERPA) protects the privacy of student records. So, the US might need an updated version of FERPA. AI systems might personalize learning, but universities would need to ensure that training data for such systems is representative of the current student population. Otherwise a personalized learning experience would not be able to deliver its main promises. In addition, the wedge between AI and faculty might create a big hole in the intellectual meaning of academic life. For some scholars, universities are places of knowledge. From their perspective, there is a difference between knowledge and information, and only humans are capable of knowing what they know and they don't. This is a point about different kind of intelligence humans and AI systems have. If we agree with this perspective, an AI university would need to redefine 'academic success.' Others have pointed out that universities are places of creativity, experimentation of ideas, and socialization. By individualizing learning experience and putting students under constant surveillance, an AI university might not be able to create an environment where students freely engage with ideas and with each other.

Appendix K: Informed Consent

Informed Consent Agreement for Participation in a Research Study

Investigators: Lauren Handel, Logan Gaudette, Rachel Arnold, Michelle Fleming

Contact Information: 508-241-0409, 508-735-9195, 774-246-6215, 774-283-1620

Title of Research Study: Artificial Intelligence in Higher Education

Sponsor: Joe Doiron, WPI

Introduction:

You are being asked to participate in a research study. Before you agree, however, we would like you to be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation.

This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the study:

1. Gather expert opinions on how AI could be beneficial to higher education in areas such as enrollment, student life, personalized career planning, and learning and instruction.
2. Make recommendations for WPI to improve using AI
3. Address some of the possible ethical concerns with using AI in higher education

Procedures to be followed:

The participants will participate in a Qualtrics survey. The participants are not obligated to answer any questions and may exit the study at any time. In Round 1, we aim to gather a broad scope of information from AI experts. We will ask these AI experts to respond to open response questions in order to reduce response bias. In Round 2, we are seeking out a narrowed scope of information from AI experts. In Round 3, we aim to prompt AI experts to make a careful and critical examination of responses from previous rounds. We will build feedback into the questions to produce consensus and divergence in this final round.

Risks to study participants: Members of the WPI staff may be uncomfortable stating their opinions about what they think is a problem at WPI. In order to ensure study participants feel comfortable throughout the study, their responses will be kept anonymous.

Benefits to research participants and others:

Participants in the study have the possible benefit of improving various processes related to education and overall student experience at WPI and other higher education institutions. The benefits to the participants also include the opportunity for the participants to voice their opinions.

Record keeping and confidentiality:

Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or its designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you. Researchers will ensure that confidentiality of all participants will be maintained.

Compensation or treatment in the event of injury:

You do not give up any of your legal rights by signing this statement.

For more information about this research or about the rights of research participants, or in case of research-related injury, contact:

The primary investigators (contact information listed above) WPI IRB Manager Ruth McKeogh (Tel. 508 831-6699, Email: irb@wpi.edu) Human Protection Administrator Gabriel Johnson (Tel. 508-831-4989, Email: gjohnson@wpi.edu)

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.